

**State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Planning and Local Assistance**

**Iron Canyon and Bear Hole Fish Passage Project
on
Big Chico Creek**

**Preliminary Engineering
Technical Report**



April 2002

**Gray Davis
Governor
State of California**

**Mary D. Nichols
Secretary for Resources
The Resources Agency**

**Thomas M. Hannigan
Director
Department of Water Resources**

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Foreword

This report summarizes the findings of the California Department of Water Resources (DWR) preliminary engineering investigation of fish passage solutions at Iron Canyon and Bear Hole on Big Chico Creek in Upper Bidwell Park in Chico, California. Included in this report are preliminary design drawings and cost estimates for project alternatives, discussion of the physical and operational characteristics of the alternatives, and a summary of construction issues and final design criteria. Attached appendices include meeting notes, hydrologic data, a preliminary geologic investigation memorandum, and an environmental evaluation summary.

Declining salmon and steelhead populations have led to increased efforts to implement restoration activities to preserve and enhance their populations, while respecting the needs of the various stakeholders. The Iron Canyon and Bear Hole Fish Passage Project is a part of these efforts. The objective of this project is to enhance Big Chico Creek's anadromous fish populations by improving fish passage over a greater range of flows. The fish passage improvements will provide access to approximately nine miles of habitat for spring-run Chinook salmon and steelhead trout.

This study was funded by the U.S. Fish and Wildlife Service (USFWS) through the Anadromous Fish Restoration Program (AFRP) of the Central Valley Project Improvement Act (CVPIA; Title 34 of Public Law 102-575, Section 3406(b)(1)).

A handwritten signature in black ink that reads "Dwight P. Russell". The signature is written in a cursive, flowing style.

Dwight P. Russell
Chief,
Northern District

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Big Chico Creek Watershed Alliance
California Department of Fish and Game
California Department of Water Resources
City of Chico
National Marine Fisheries Service
United States Fish and Wildlife Service

Recommendations

The California Department of Water Resources has completed a concept level engineering investigation of fish passage solutions at Iron Canyon and Bear Hole on Big Chico Creek.

The Big Chico Creek Fish Passage Design Technical Team recommends advanced engineering of the following:

Iron Canyon

Repair of the existing ladder, reducing drops between pools to 1.5 feet.

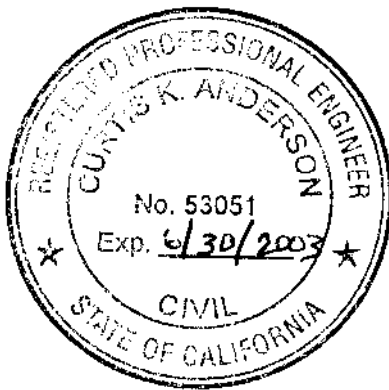
Bear Hole

Construction of 2 gradient control structures

Iron Canyon and Bear Hole Fish Passage Project on Big Chico Creek

REGISTERED ENGINEERS' STAMPS

The technical information contained in this preliminary engineering technical report has been prepared by or under the direction of the following registered engineers.



Date: 4/3/2005

General

Introduction

This report summarizes the findings of the DWR preliminary engineering investigation of fish passage solutions at Iron Canyon and Bear Hole on Big Chico Creek in Upper Bidwell Park, Chico, California (Figure 1). Included in this report are preliminary design drawings and cost estimates for project alternatives, discussion of the physical and operational characteristics of the alternatives, and a summary of construction issues and final design criteria. Attached appendices include technical design team meeting notes, hydrologic data, preliminary geologic investigation summary, cultural resources summary, and an environmental summary.

Project Background

Declining salmon and steelhead populations have led to increased efforts to develop restoration activities to preserve and enhance these populations, while respecting the needs of various stakeholders. The Iron Canyon and Bear Hole Fish Passage Project is a part of that effort. The objective of the project is to enhance Big Chico Creek's anadromous fishery by improving fish passage over a greater range of flows. Improved fish passage will provide access to approximately nine miles of habitat for spring-run Chinook salmon and steelhead trout.

Big Chico Creek is located in Butte and Tehama Counties of California and is encompassed by a watershed area of approximately 72 square miles. Big Chico Creek originates on the western slope of Colby Mountain and flows approximately 45 miles to its confluence with the Sacramento River.

The existing Iron Canyon fish ladder (Figures 2 and 3) was constructed in 1958 by the California Department of Fish and Game (DFG) with assistance from the Magalia Honor Camp of the State Division of Forestry. The original fish ladder consisted of fourteen small concrete weirs (steps) that provided a passage route for salmon past the massive rockslide that occurred in the early 1900's. The limited fish passage that does occur beyond Iron Canyon since the original fish ladder was constructed is believed to take place during higher flow conditions. Over the years, the fish ladder has sustained damage and concrete has been worn to the point that rebar is now exposed and various leaks exist. This damage has made fish passage at low flows extremely difficult or impossible. Currently, the upper portion of the fish ladder is not passable at low flows because water does not flow into it. The lower portion of the fish ladder is marginally passable at low flows because of recent damage to the lower portion of the fish ladder. Since its construction, DFG has been responsible for maintaining the fish ladder and making repairs as needed.

The Bear Hole portion of the investigation is concentrated on an area where a natural constriction occurs in the creek just downstream of a swimming area known as Bear Hole. There is a six-foot drop in the creek bed elevation, and a 5-foot drop in the

low flow water surface. These drops may make fish passage difficult during low flows. Bear Hole is a natural site where no fish passage improvements or stream restoration have been made. Fish passage has not been a problem in the past, but recent changes in the creek may have created a situation where fish passage may be a problem at low flows. No studies or consistent observations of fish passage have previously been conducted at this location.

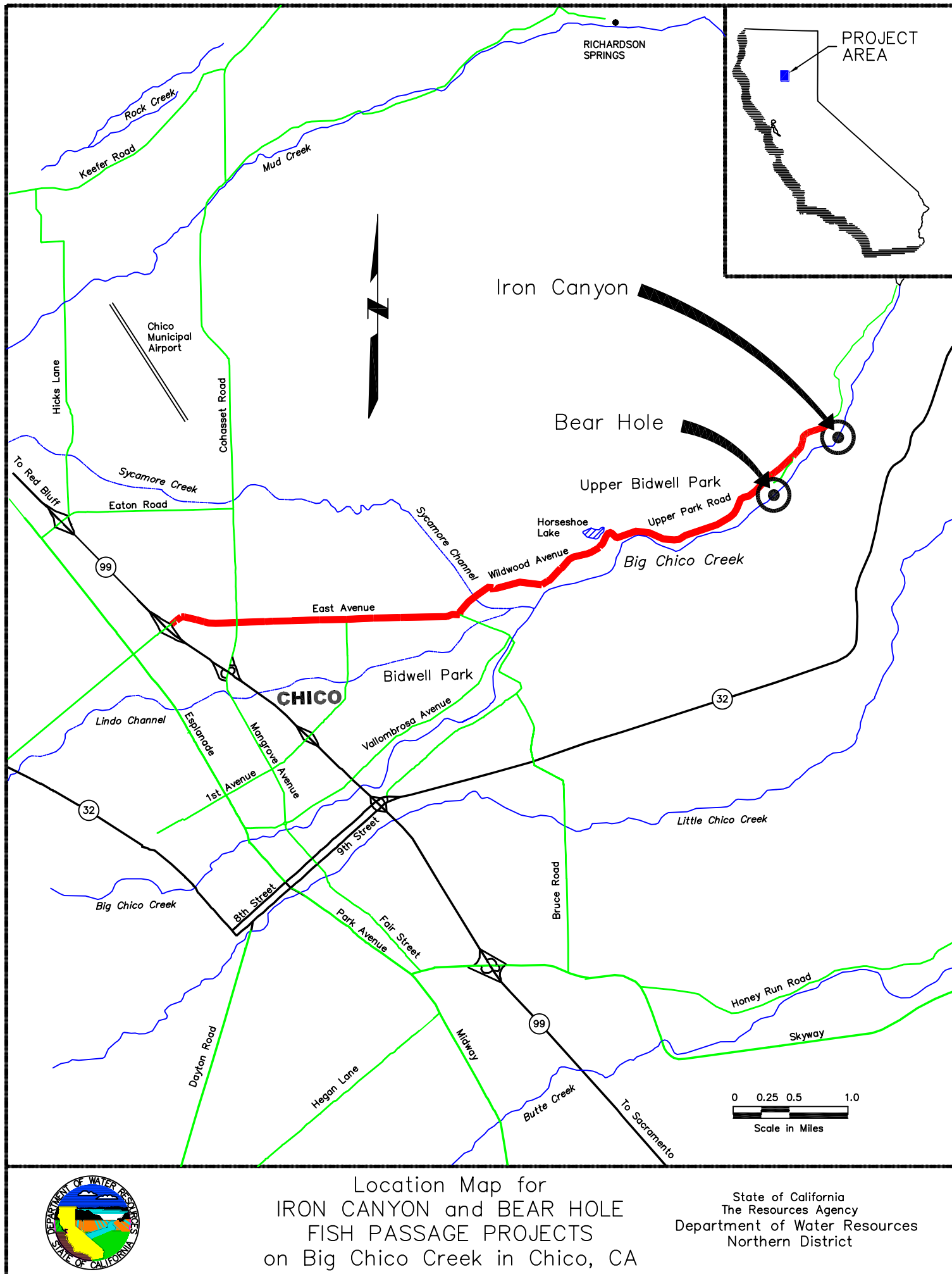


Figure 1. Location Map

Project Location and Access

The Iron Canyon and Bear Hole project areas are located in Butte County on Big Chico Creek, approximately 13 miles upstream of its confluence with the Sacramento River. The project areas are on City of Chico property in Upper Bidwell Park.

Access for construction would be from Highway 99 at the East Avenue exit, then proceed east about 3 miles to Wildwood Avenue, and turn left onto Wildwood Avenue, which turns into Upper Park Road. The project sites are accessible from Upper Park Road on the north side of Big Chico Creek (Figure 1, Sheet 2, and Sheet 12).

Special Project Notes

The preliminary cost estimates are subject to review by DWR, Division of Engineering (DOE) staff. The estimated quantities and costs shown in Tables 2, 9, 16, 17, 18, and 19 and the preliminary engineering drawings are not intended for bidding or construction purposes, as final designs may result in changes to any or all quantities and costs. Final designs will be subject to the approval of DFG, National Marine Fisheries Service (NMFS), USFWS, and the City of Chico.

California Department of Fish and Game



Figure 2. Original construction of the Iron Canyon fish ladder (1958).



Figure 3. Present Iron Canyon fish ladder (2000).

Project Alternatives

DWR, Northern District (ND), is under contract with USFWS to provide preliminary engineering designs and cost estimates for fish passage alternatives at Iron Canyon and Bear Hole on Big Chico Creek. Several stakeholder meetings were held with representatives of local, State, and federal agencies to discuss the alternatives of the project. The stakeholder group considered many alternatives to improve fish passage, including those listed below. The alternatives were evaluated on numerous factors including fish passage, operation and maintenance, location and condition of existing facilities, stream characteristics, stream hydrology, site geology, biological criteria, owner liability, and economics. For Iron Canyon, eight alternatives were narrowed down to three after consultation with the fish passage technical design team. At Bear Hole, seven alternatives were also narrowed down to three after consultation with the fish passage technical design team. The 3 alternatives for Iron Canyon and Bear Hole were investigated and the results are summarized in this preliminary engineering report.

Alternatives Considered for Iron Canyon

The initial alternatives considered for Iron Canyon are listed below. Alternatives investigated in this report are underlined.

- Alternative 1 - Do nothing.
- Alternative 2 - Repair existing facilities and make minimal improvements to make the fishway operational.
- Alternative 3 - Repair existing facilities and make some major improvements. This alternative would focus on some of the more serious problem areas in the existing facilities. Drops between pools would be designed to 2 feet or less.
- Alternative 4 - Repair existing facilities and make some major improvements. This alternative would focus on some of the more serious problem areas in the existing facilities. Drops between pools would be designed to 1.5 feet or less.
- Alternative 5 - Build hybrid facilities – Investigates the possibility of fixes using different ladder or weir types at certain problem areas.
- Alternative 6 - Construct a new fish ladder that meets all typical fishway standards.
- Alternative 7 - Convert Iron Canyon into a gradient structure.
- Alternative 8 - Trap and relocate fish.

Alternative 1 was abandoned because it does not meet the goals of this restoration project.

Alternative 2 is one of the options carried through preliminary design (Sheets 4 and 6). Minimal improvements of the existing structure to make it functional again could be done at a relatively low cost.

Alternative 3 is one of the options carried through preliminary design (Sheets 4, 7, and 9). Improvements of the existing structure along with adjusting drops between pools to 2 feet or less would be accomplished to improve fish passage at low flows.

Alternative 4 is one of the options carried through preliminary design (Sheets 5, 8, and 9). Improvements to minimize drops between pools to 1.5 feet or less would be accomplished to improve fish passage at low flows. This would involve constructing new weirs within the limits of the existing structure.

Alternative 5 was abandoned because the technical team believed that hybrid structures would not provide a suitable solution for fish passage because of complex hydraulic conditions that would require frequent adjustments.

Alternative 6 was abandoned because of the physical conditions of the project site and the risk involved with maintaining a new structure. This alternative would likely involve disturbing a large reach of the creek to be able to construct a new structure. An extensive topographic survey and geological investigation would be required to begin investigating alignments for a new fish ladder. The investigation, design, and construction of a fish ladder that meets all standards and criteria would likely cost about 5-10 million dollars. The large investment in a new structure would need to include major improvements for access to the remote site to maintain it to standards. There would also be a possible need to run power to the site for any equipment and to provide lighting for maintenance. Though this alternative would improve fish passage over a greater range of flows, the large cost and area of disturbance were not considered to be warranted by the fisheries agencies.

Alternative 7 was abandoned for reasons similar to those for Alternative 6. An extensive topographic survey and geological investigation would be required to begin looking at pursuing this alternative. It would also likely impact a fairly long reach of the creek to accomplish suitable fish passage. Though this alternative would improve fish passage over a greater range of flows, the large cost and area of disturbance was not considered to be warranted by the fisheries agencies.

Alternative 8 was abandoned because it does not meet the goals of this restoration project.

Alternatives Considered for Bear Hole

The initial alternatives considered for Bear Hole are listed below. Alternatives investigated in this report are underlined.

- Alternative 1 - Do nothing.
- Alternative 2 - Enlarge the constriction area.
- Alternative 3 - Enlarge the constriction area and add gradient control structure(s).
- Alternative 4 - Add gradient control structure(s) without enlarging the constriction area.

- Alternative 5 - Placing fill in the channel downstream of the constriction area.
- Alternative 6 - Construct a new fish ladder that meets all standards and criteria.
- Alternative 7 - Trap and relocate fish.

Alternative 1 was abandoned because it does not meet the goals of this restoration project.

Alternative 2 is one of the options carried through preliminary design (Sheets 13 and 14). Enlarging the fish passage corridor through the existing constriction area is a possible method of improving fish passage. The cost of this alternative is dependent on how much excavation could be accomplished without impacting the creek bed above the existing constriction area.

Alternative 3 is one of the options carried through preliminary design (Sheets 13, 15, and 16). The introduction of a gradient control structure(s) placed downstream of the constriction area to raise the water surface at the constriction area would improve fish passage. In addition to constructing the gradient control structure(s), enlargement of the fish passage corridor by excavating the constriction area would be included.

Alternative 4 is one of the repairs carried through preliminary design (Sheets 13, 15, and 16). The introduction of a gradient control structure(s) placed downstream of the constriction area to raise the water surface would be included.

Alternative 5 was abandoned because the technical team decided this type of repair was extreme and that a simpler solution could be made for improving fish passage. Fill that is added to improve fish passage would need to be stabilized so it would not flush out. In addition, a low flow channel would need to be established to ensure adequate depth during lower flows for fish passage.

Alternative 6 was abandoned because the technical team decided that a new fish ladder would be too expensive and would not be required to improve fish passage at this site.

Alternative 7 was abandoned because it does not meet the goals of this restoration project.

Description of Investigation

ND staff began the preliminary engineering process with site surveys and hydrologic analyses. DFG and NMFS fish ladder design standards were referenced for determining design requirements for the alternatives investigated. A DFG Biologist and DFG and NMFS Engineers were consulted during the design phase. A DWR Geologist conducted a geologic inspection of the project sites, and DWR Environmental Specialists conducted site evaluations.

Surveying

ND staff began site surveying at Iron Canyon in May 2000. Because of the nature of the terrain, the survey consisted primarily of identifying the existing fish ladder, creek profiles, and flow profiles. Site surveying at Bear Hole began in June 2000 and consisted of surveying flow profiles and site topography. It was determined, because of the difficulty in surveying the topography, that aerial photography would be beneficial to the design process. Air targets were set in late June 2000 and surveyed with a Global Positioning System (GPS). The basis of control for the aerial photography was NAD 83, State Plane, Zone 2 (feet) coordinates for the horizontal datum and NAVD 88 (feet) for the vertical datum. A continuous series of overlapping air photos were taken from Bear Hole to Iron Canyon. Color photos and a rectified photo mosaic of the reach were produced.

Hydrology

The hydrologic data used for Big Chico Creek was collected from the USGS gaging station number 11384000 for water years 1931 to 1986 and the DWR gaging station number A04250 for water years 1997 to 1999. A summary of historic flows is listed in Appendix B. The newer DWR gaging station is located approximately one and a half miles downstream of the abandoned USGS gaging station, which is just downstream of the Bear Hole site. There are no records near this location for water years 1987 to 1996. Even with the gap in data, there is still over 50 years of hydrologic data, which is sufficient for summarizing flows in Big Chico Creek.

Geology

A DOE geologist performed a geologic inspection of the project sites in September and November 2000. The inspection focused on the stability of rocks near and within the creek bed and the ability to work with basalt, found new structures, and deepen pools within the existing fish ladder. In September 2000, DFG crews used a jackhammer and a rock drill to enlarge a constriction area in the existing fish ladder. This work was valuable to the geologic analysis because it demonstrated the rate at which the basalt could be drilled or chipped. A memorandum summarizing the inspection is listed in Appendix C.

Environmental

DWR Environmental Specialists and an Archeologist performed site surveys of the project sites to identify potential cultural resources or environmental issues.

A cultural resource survey was conducted at the two project sites. The survey consisting of a historical records search by staff at The Northeast Center of the California Historical Resources Information System, Chico State University, and a field visit to the project sites. The survey revealed that no cultural resources or historic properties would be affected or impacted by the currently proposed project (see Appendix D).

The environmental survey consisted of field surveys to investigate potential impacts to sensitive plants, fish and wildlife, aesthetics, water quality, recreation, and land use. Appendix E contains a list of potentially required environmental permits and an environmental checklist for the proposed project. No threatened or endangered plant species were identified within the project area.

Iron Canyon

Summary of Findings

Comparison of Viable Alternatives

Alternative 2 - Minimal Improvements

Cost Estimate
\$ 145,000

- Install a new weir 1 at the steel bar.
- Repair weirs 2, 3, and 4 with steel or concrete caps.
- Repair the right bank walls on pools 3 and 4.
- Repair the floor of pool 3, keeping the underflow channel intact.
- Repair and seal leaks in weirs 10 - 17.
- Seal the large leak in pool 10.
- Repair the exit structure (weir 17) and incorporate some flow control.
- Excavate the loose materials in all pools.
- Seal various leaks throughout the fish ladder.

Alternative 3 - Major Improvements (2-foot drops)

Cost Estimate
\$ 660,000

- Install a new weir 1 at the steel bar.
- Adjust all weirs to consistent 3-foot lengths and 2-foot drops throughout the entire fish ladder. Use variable weirs and steel caps where appropriate.
- Repair the right bank walls on pools 3 and 4.
- Armor the walls of pool 3.
- Repair the floor of pool 3, keeping the underflow channel intact.
- Replace the left bank wall of pool 6.
- Reconstruct weir 7.
- Repair the concrete sandbag section of weir 7.
- Construct a new weir in pool 7.
- Repair and seal the leaks in weirs 10 - 17.
- Seal the large leak in pool 10.
- Repair the exit structure (weir 17) and incorporate some flow control.
- Stabilize the headpool floor.
- Repair/Replace the concrete bag wall near the exit.
- Excavate the loose materials in all pools.
- Seal various leaks throughout the fish ladder.

Alternative 4 - Major Improvements (1.5 foot drops)

Cost Estimate
\$ 737,500

- Install a new weir 1 at the steel bar and a head dissipation structure in pool 1.
- Adjust all weirs to consistent 3-foot lengths and 1½-foot drops throughout the entire fish ladder. Use variable weirs and steel caps where appropriate.
- Repair weirs 2, 3, and 4 with steel or concrete caps.
- Repair the right bank walls on pools 3 and 4.
- Armor the walls of pool 3
- Repair the floor of pool 3, keeping the underflow channel intact.
- Construct a new weir in pool 5.
- Replace the left bank wall of pool 6.
- Construct a new weir in pool 6.
- Construct a new weir in pool 7.
- Replace the weir 7 group.
- Construct a new weir in pool 7 or 8, or plug the leak in weir 8.
- Repair and seal the leaks in weirs 10 - 17.
- Seal the large leak in pool 10.
- Construct a new weir in pool 12.
- Repair the exit structure (weir 17) and incorporate some flow control.
 - Stabilize the headpool floor.
 - Repair/Replace the concrete bag wall near the exit.
- Excavate the loose materials in all pools.
- Seal various leaks throughout the fish ladder.

Advantages and Disadvantages

The main advantage of Alternative 2, is that repair of the existing fish ladder would make it close to its original configuration, which would make it marginally passable during low flows at an economical cost. Flow would be restored to the upper fish ladder section, the large leak in pool 10 would be repaired to maintain a sufficient water surface for passage to pool 11, and the steel bar structure in the vicinity of weir 1 would raise the water surface in pool 1 for passage to pool 2. Proper jumping depth for fish at low flows would also be provided. The fish ladder would essentially be as effective as it had been at the time of construction in the late 1950's.

The main disadvantage of Alternative 2 is that the existing fish ladder would still have inconsistent drops. The average drop between pools is about 2 feet, but ranges from approximately 1 to 3 feet. Although the 1-foot drops would be ideal, the 3-foot drops are difficult for passage. Most pools would not meet jumping depth or energy dissipation standards. Also, flow control would only be possible at flows below 100 cfs. Alternative 2 would make the fish ladder operational, but numerous leaks and sections of worn concrete would still exist. All fish ladder standards would not be met.

The main advantage of Alternative 3 is that the existing fish ladder would be repaired to an operational state and some major improvements made for fish passage. The drops between pools would be repaired to a consistent height of 2 feet while fixing all weir lengths to an equivalent 3-foot length. All major leaks and deteriorating sections of the fish ladder would be repaired so the fish ladder hydraulics and integrity would be improved. Jumping depth and energy dissipation standards would also be improved.

The main disadvantage of Alternative 3 is that it would likely only improve the function of the fish ladder for flows below 100 cfs. Also, the cost is higher than Alternative 2. All fish ladder standards would not be met.

The main advantage of Alternative 4 is that the existing fish ladder would be repaired to an operational state and some major improvements made for fish passage. The drops between pools would be repaired to consistent drops of 1.5 feet with the addition of 5 weirs within the limits of the existing fish ladder, while fixing all weir lengths to an equivalent 3-foot length. All major leaks and deteriorating sections of the fish ladder would be repaired so the hydraulics and integrity would be improved. Jumping depth and energy dissipation standards would also be improved.

The main disadvantage of Alternative 4 is that it would likely only improve the function of the fish ladder for flows below 100 cfs. Also, the cost would be higher than Alternatives 2 and 3. All fish ladder standards would not be met.

Conclusions and Recommendations

The alternative that would provide the best fish passage in Iron Canyon would be Alternative 6 or 7. However, these alternatives would be the most costly and impact the longest reach of the existing creek. Maintenance of a new fish ladder that meets all standards would require the most time and cost to maintain. This large investment for improving fish passage at this site is not a priority for the fisheries agencies at this time.

Therefore, the technical team decided Alternative 4, which would repair and improve the existing fish ladder in Iron Canyon, is the preferred alternative. Repairing most of the fish ladder, and reducing the drops between pools from an average of 2 feet to consistent 1.5-foot drops should improve fish passage primarily at lower flows. Increasing the jumping depths in the pools and improving the energy dissipation within the fish ladder will also help improve fish passage in the existing fish ladder. Sightings of fish in pools below Iron Canyon are a common occurrence as winter flows recede in Big Chico Creek. The improvements of this alternative should help those fish that currently have a difficult time getting past Iron Canyon during the low flows of spring and summer. The hydrology data in Appendix B show the historic trend of flows in Big Chico Creek since they were first recorded in 1930.

Note: In August 2001, ND staff accompanied DFG staff to inspect a potential fish passage barrier located about 200 feet downstream of the entrance to the Iron Canyon fish ladder. This potential barrier may be a problem during low flow conditions of less

than approximately 30 cfs. It is possible that movement of boulders and sediment could have caused the hydraulics in this area to change recently. If it is decided to proceed with the improvements proposed for the Iron Canyon fish ladder, this newly developed potential barrier should be investigated and repaired along with the work proposed for Iron Canyon.

ALTERNATIVE 2 - Minimal Improvements

Because it is possible to separate the project area into lower and upper sections, and different alternatives could be selected for each, they will be discussed separately. The lower section will be defined as the area between the downstream extent of the fishway and Pool 8 (Sheet 3). The upper section will be defined as the area between Pool 8 and the upstream extent of the fishway. The names of tasks listed in the alternatives will incorporate the alternative number, upper or lower section designation, and task number. For example, Task 3L-2 would be Alternative 3, Lower section, Task 2.

Lower Section

For the lower section, Alternative 2 involves two tasks:

- 2L-1 Repair existing damaged concrete structures.
- 2L-2 Improve entrance conditions.

TASK 2L-1 - Repair existing damaged concrete structures.

Task 2L-1 is needed because some of the existing facilities are badly damaged and worn to the extent that the fishway does not function as intended, and its structural integrity is questionable. Currently at low flows, at least one pool leaks so much that a pool is not maintained, and the water surface drop from pool 2 to pool 1 is excessive due to the failure of the existing weir 1. As shown in Figure 4, concrete portions of the lower ladder have failed or worn to the point that rebar is exposed. The fish ladder was intentionally dewatered at the time of the photo so that it could be inspected.

PROPOSED WORK

Use steel or other material to cap at least the three most badly damaged weir crests - These are weirs 2, 3, and 4. Figure 4 shows weirs 3 (foreground), 4, 5, and 6. The caps could be manufactured so they would fit over the top of the existing weirs and be bolted in place. A sealant could then be used around the edges of the cap to make a seal between the steel and concrete. The new weir caps would be set at the proper elevations to minimize the drops between pools. Slots for flashboards should be incorporated into the caps where appropriate.

Replace two "blown-out" fish ladder walls - These are the right-side walls of Pools 3 and 4. The walls of Pools 3 and 4 are shown in Figures 5 and 6, respectively. It is unlikely these walls can be repaired due to extensive damage, so they should be replaced. Both walls are made up of concrete sandbags and poured concrete. The wall of Pool 3 was partially removed by DFG personnel as remediation for a problem that occurred downstream in the ladder. The wall of Pool 4 appears to have failed naturally over time.



Figure 4. Damaged lower fish ladder sections.



Figure 5. Right bank side of Pool 3 fish ladder wall. This wall once extended across the gap indicated by the dashed lines.



Figure 6. Right bank side of Pool 4 fish ladder wall.



Figure 7. Floor of Pool 3 with water flowing over Weir 4.

Repair the floor of Pool 3 - It appears that the floor of Pool 3 was constructed as a bridge over a portion of the creek channel. This may have been important because the fish ladder crosses the creek channel, and bridging the channel would allow a portion of the creek flow to pass under the fish ladder instead of overtopping the walls. Presently, the floor is concrete, but has a large hole in it. This hole is covered with a sheet of plywood. Figure 7, above, shows the plywood floor, and Figure 8, on the following page, shows water flowing under the fish ladder. If the plywood is not in place, it is possible at lower flows for all of the water in the ladder to pass through the floor of this pool and not over the downstream weirs.

The underflow channel is a desirable feature that should be maintained. Repair of the damage should consist of a new concrete or steel plate floor. A steel plate floor may be easier to install than concrete, and the steel plate could be laid on top of the existing floor if it is determined that it is structurally sound. A sealant would then be used around the steel to create a watertight bond between the new steel floor and the existing concrete. Another advantage of using steel is that it could be removed for maintenance if the flow path under the ladder became clogged.

Minor repair of Pool 5 - Pool 5 contains minor leaks that can be repaired.

Minor repair of Pool 6 - Pool 6 also contains some minor leaks that should be easily repairable.



Figure 8. Water flowing under the left bank side of Pool 3.

TASK 2L-2 - Improve entrance conditions.

Task 2L-2 is needed because of poor hydraulics and a large jump for fish at Weir 2. Weir 2 is the ladder entrance under existing conditions. Originally, Weir 2 was a wall that guided water through a different route and set of weirs, but the natural movement of a large boulder has closed off that route. DFG built a steel and timber weir near one of the original weirs, but this weir has been damaged and is no longer functional. The remaining steel bar is shown in the upper center portion of Figure 9, on the following page.

PROPOSED WORK

Raise the water surface elevation of Pool 1 - To improve passage from Pool 1 to Pool 2, the low flow water surface of Pool 1 could be raised about 1.5 feet. This would put the pool water surface high enough to ease passage past Weir 2 and into the lower section of the existing fish ladder. This could be accomplished three different ways.

- 1) Repair and reuse the steel bar weir frame installed by DFG.
- 2) Place a large rock near the steel bar installed by DFG. A rock of the proper size could allow pool 1 to backwater to give the desired effect. The main drawback is that it may be difficult to get the rock set to give the exact effect that is desired. Additionally, to prevent movement in the future, the rock would have to be anchored into place.
- 3) Build a concrete or steel weir in the same location where the steel bar is located. This option may be difficult because of the problems associated with dewatering this area.

It is recommended that the third option of building a concrete or steel weir in the same location is the best fix if the site can be completely dewatered.

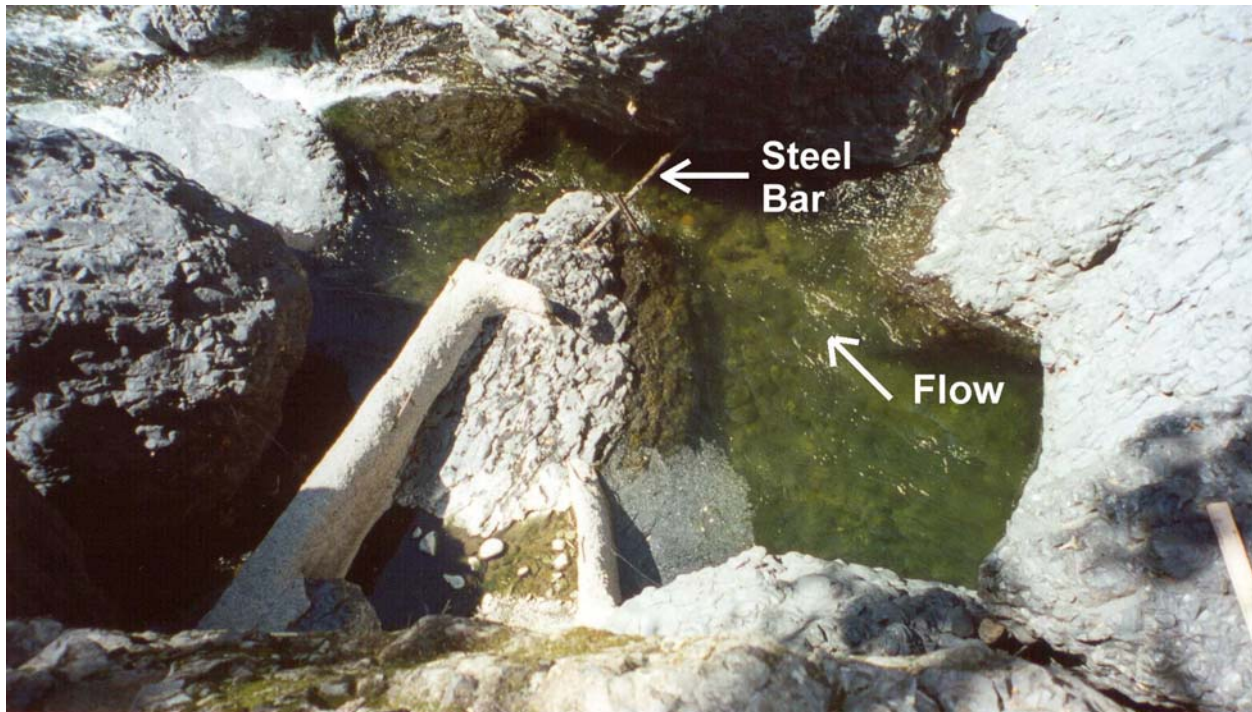


Figure 9. Pool 1, Weir 1, and steel bar (24 cfs).

Upper Section

For the upper section, Alternative 2 involves two tasks:

- 2U-1 Repair existing damaged concrete structures.
- 2U-2 Improve exit conditions.

TASK 2U-1 - Repair existing damaged concrete structures.

Task 1 is needed because some of the existing facilities are damaged and worn to the extent that the fishway does not function as intended, and its structural integrity is questionable. At least one pool leaks enough so that a pool is not maintained during low flows. Also, some weirs have deteriorated to the point that water now flows under or around them. The weirs in the upper section, however, are generally not as eroded as much as the weirs in the lower section. This is probably true because the upper section is shielded from the main force of the water in the creek, and it takes in a smaller percentage of the total creek flow.

PROPOSED WORK

Repair or replace weirs - The work required to return the existing weirs to service is summarized in Table 1, on the following page. Most of the work needed is simply sealing leaks where concrete meets rock. This type of repair should be relatively easy to perform. There are leaks under or around Weirs 12, 13, and 17, but it should be possible to repair them. Weirs 14 and 16 are in poor condition and they should be

replaced. These weirs are relatively small and replacement should be easy. Weir 16 can be seen in the center of Figure 10.

Repair leaks - There are numerous leaks between pools and into and out of the upper ladder section along almost its entire length. The repair of leaks would include both sealing leaks where the existing concrete structures meet rock as described above, and sealing between the rocks that make up the sidewalls of the ladder. The upper section of the ladder is out of the main creek channel, so dewatering should be relatively easy. The work needed to repair the leaks is summarized in Table 1. The repair of Pool 10 may be difficult because there is a large cavity where water can flow out of the pool. DFG has attempted to repair Pool 10 in the past, but were not completely successful.

Table 1. Summary of repair work for weirs and pools for Task 2U-1.

Number	Weir	Pool
9	No Action	No Action
10	Repair as Needed	Seal Large Leak
11	Repair as Needed	Seal Leak
12	Repair (Leak Under Weir)	No Action
13	Repair	No Action
14	Replace	No Action
15	Repair As Needed	No Action
16	Replace	No Action
17	Repair (Leak Under Weir)	No Action



Figure 10. Weir 16 (looking downstream).

TASK 2U-2 - Improve exit conditions.

Task 2 is needed because at low flows, the exit weir crest is not submerged (Figure 11). The only water entering the fish ladder comes from leaks between rocks and under the exit weir.

Special note: Based on observations by DWR personnel, the creek stage-discharge relationship has changed significantly at the fish ladder headpool over the last year. This difference is most noticeable for low creek flows (20 - 50 cfs range). For a given flow, the stage at the fish ladder exit now (spring 2001) appears to be more than 0.5 foot higher than it was last year (fall 2000). The Figure 8 photo, taken in fall 2000, shows that the headpool water surface elevation is just below the weir crest at 27 cfs. Measurements taken by DFG in June 2001 show that the creek stage at this location is 0.5 foot higher with a lower total creek flow (23 cfs). This may be attributed to a change in the creek channel or seasonal variation.

DWR is attempting to make the fish ladder designs as flexible as possible. If this change in stage is caused by dynamic changes in the creek channel, this is another indicator that maintenance, and possibly new construction, will need to be an ongoing commitment for the entity that assumes ownership of these facilities.

PROPOSED WORK

Lower the invert elevation of the exit weir and make it an adjustable structure (Figure 12) – The proposed adjustable exit structure would require modification of the existing structure to include slots for both horizontal and vertical flashboards. The invert elevation of the new structure would be lowered to allow water to flow into the upper section of the fish ladder when the creek stage is low. Boards could be added as the creek stage increases to help limit the amount of water flowing into the fish ladder.

Another method investigated to improve exit conditions of the fishway was to build a structure in the creek to allow backwater into the fish ladder exit. The structure would work well during low creek flow conditions but would force more water into the fish ladder as the creek stage increased. This is undesirable because the fish ladder has a limited capacity, and too much water would enter the fish ladder.

Maintenance

To keep the fishway operating as intended, under Alternative 2, regular maintenance and minor repairs would be required. Significant work may be required if changes in the creek cause portions of the fishway to become ineffective. At creek flows of more than about 100 cfs, maintenance and adjustments may not be possible. This may limit the time that work can be performed to the months from late spring through fall.

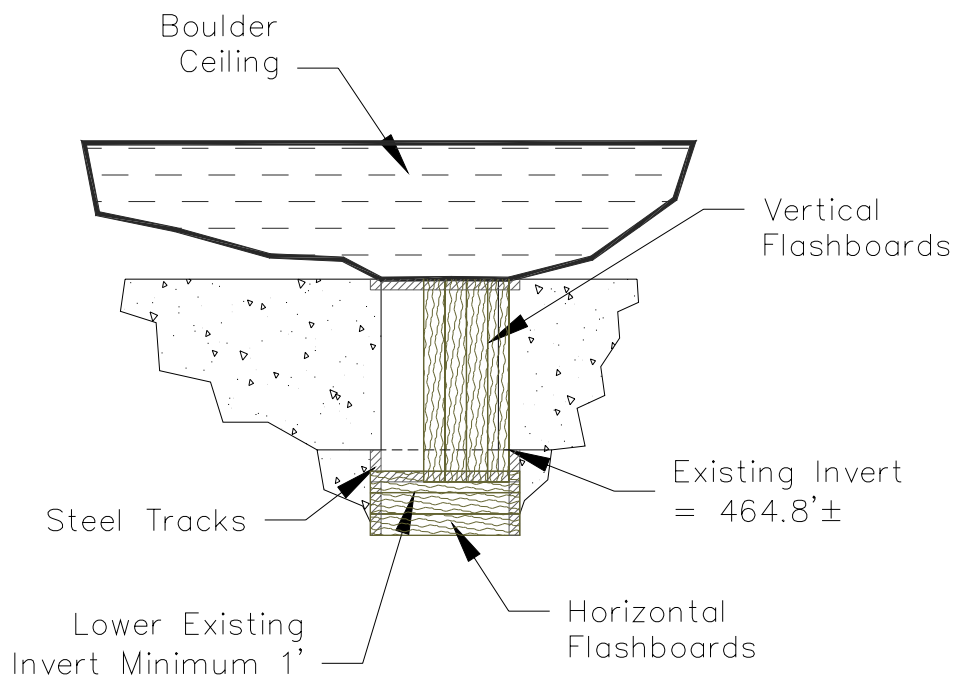
Regular maintenance will include inspection of the entire fishway to ensure proper operation and sediment and debris removal.

Less frequent, but more significant work may include repair of damaged concrete structures, sealing leaks, and pool excavations. Major work may be required because of changes in channel hydraulics or geologic conditions. These types of changes have resulted in significant work in the past. Presently, this site is only accessible by foot. Thus, specialized equipment, such as a crane or helicopter, may be required when performing significant repairs.

An operations and maintenance manual should be developed during the final design process to provide information on how the fish ladder should be operated and maintained.



Figure 11. Fish ladder exit weir. (27 cfs)



**Proposed Modifications to Existing
Weir 17 (Exit)**

(Looking Downstream)

Figure 12. Proposed adjustable exit weir.

Table 2. Iron Canyon Alternative 2 preliminary cost estimate.

**Big Chico Creek - Iron Canyon Fish Passage Project
Preliminary Cost Estimate for Design and Construction
Alternative 2**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
<u>MISCELLANEOUS</u>					
1	Mobilization/Demobilization	1	LS	\$ 6,000	\$ 6,000
2	Site Work, Access & Mitigation	1	LS	\$ 4,000	\$ 4,000
3	Construction Scaffolding	1	LS	\$ 2,000	\$ 2,000
					\$ 12,000
<u>FISH LADDER LOWER SECTION</u>					
4	Weir Repair, Weir 1	1	LS	\$ 2,500	\$ 2,500
5	Weir Repair, General	3	EA	\$ 1,500	\$ 4,500
6	Pool 3 Floor Repair	1	LS	\$ 1,000	\$ 1,000
7	Pool Leak Repair, General	1	LS	\$ 1,500	\$ 1,500
8	Excavation - Loose Rock	5	CY	\$ 200	\$ 1,000
9	Excavation - Concrete	1	CY	\$ 1,000	\$ 1,000
10	Concrete (Walls & Baffles)	3	CY	\$ 1,000	\$ 3,000
11	Dewatering	3	DAY	\$ 2,500	\$ 7,500
					\$ 22,000
<u>FISH LADDER UPPER SECTION</u>					
12	Pool 10 Repair	1	LS	\$ 5,000	\$ 5,000
13	Exit Structure	1	LS	\$ 1,500	\$ 1,500
14	Excavation - Loose Rock	20	CY	\$ 200	\$ 4,000
15	Excavation - Concrete	1	CY	\$ 1,000	\$ 1,000
16	Concrete (Walls & Baffles)	4	CY	\$ 1,000	\$ 4,000
17	Dewatering	2	DAY	\$ 1,000	\$ 2,000
					\$ 17,500
18	Construction Cost				\$ 51,500
19	Contingency @ 30%				\$ 15,500
20	Construction Cost Subtotal				\$ 67,000
21	Engineering				\$ 26,000
22	Environmental				\$ 13,000
23	Construction Inspection				\$ 13,000
24	Contract Administration				\$ 26,000
25	Total				\$ 145,000

ALTERNATIVE 3 - Major Improvements (2-foot drops)

Lower Section

For the lower section, Alternative 3 involves four tasks:

- 3L-1 Repair existing damaged structures and build new structures.
- 3L-2 Improve entrance conditions.
- 3L-3 Adjust drops between pools to 2 feet or less.
- 3L-4 Excavate pools.

TASK 3L-1 - Repair existing damaged concrete structures and build new structures.

Task 3L-1 is needed for the reasons described in Task 2L-1.

PROPOSED WORK

The proposed work for this task is similar to that of Alternative 2 - The main difference is that a greater effort will be taken to fix or improve areas that may become problems in the future. All work proposed for Task 2L-1 is included in this alternative in addition to the items discussed below.

Strengthen and armor the walls of pool 3 - These repairs should be made because these walls will become overflow weirs when the creek flow increases whenever the capacity of the channel under the fish ladder is exceeded. The existing right-side wall is damaged (Figure 5) and must be replaced. The left-side wall is in fair condition, but because of its location in the creek channel, it is subject to damage from higher flows. For this reason, a new concrete wall should be constructed next to the existing wall that will serve to effectively increase its thickness. Additionally, both walls should be armored with steel to help protect them from being damaged during higher flows. The right-side wall should be set at a specific elevation or notched so that some water can leave the ladder and decrease the flow into pool 2.

Replace left wall of pool 6 - Pool 6 is in fair condition, but the left wall should be replaced. This wall is shown in Figure 13 on the following page. The reasons it should be replaced are that there is a fair amount of leakage where the wall meets the natural rock and the concrete is significantly eroded on the upstream end. Because of the damage and the small size of the wall, replacement will be easier and more effective than any attempt to repair it.

Build new structure in pool 7 or stop leaks through Weir Group 8 - Under present conditions, approximately 30 cfs can flow underneath or through voids in Weir Group 8. Some of this flow goes through cracks and two small orifices, but most appear to be through an underwater tunnel. This alternative relies on the ability to create a 2-foot head differential at or near Weir Group 8 during low flows. For this reason, most or all of the submerged passage routes must be blocked or a new structure (probably a weir) built to take the place of Weir Group 8. A possible new weir location is labeled "C" in

Figure 14. The underwater tunnel has a cross sectional area of approximately 18 square feet and its location is identified by the dashed lines labeled "A" in Figure 14.



Figure 13. Left wall of Pool 6 (24 cfs).

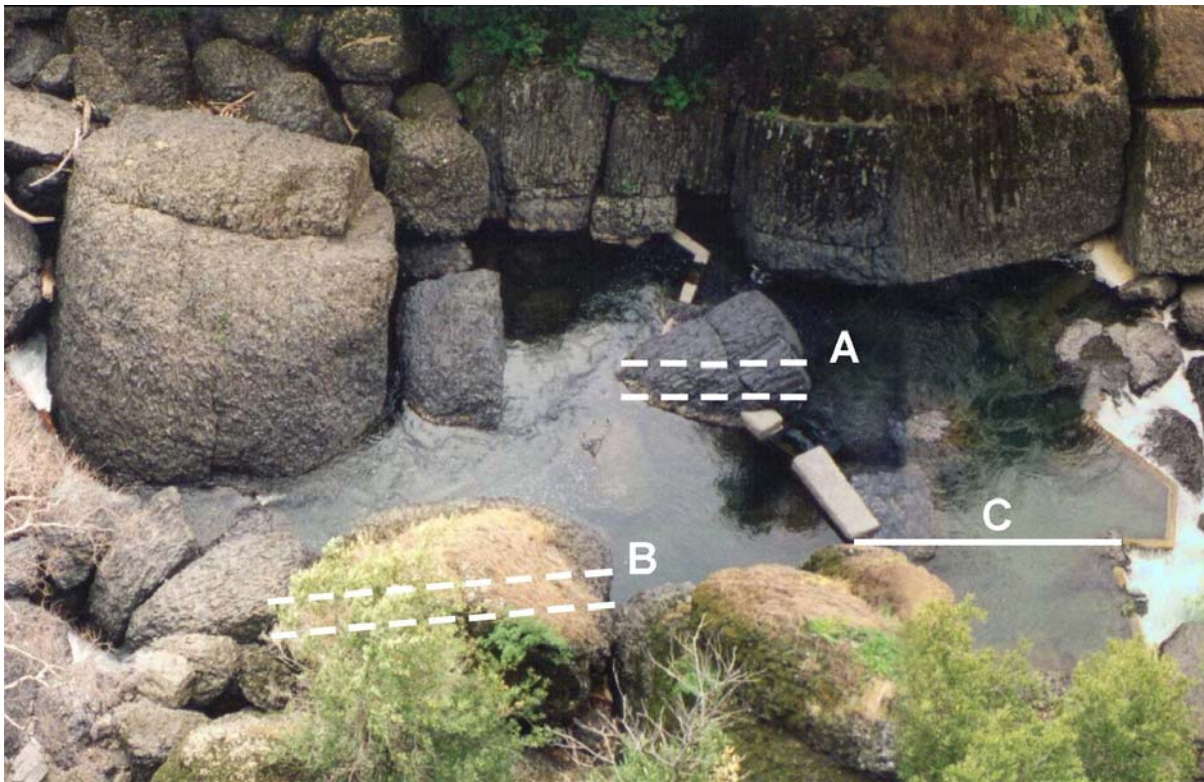


Figure 14. Underwater tunnels and new weir location.

It is likely that suitable foundation materials are not far below the surface in the area indicated in Figure 14. This new weir should contain a notch, set at the same elevation as is proposed for Weir 8. If a new weir were constructed, Weir 8 would remain in place and not be altered except to repair leaks on the right bank side if the new weir does not entirely cross Pool 7.

If a new weir in Pool 7 is constructed as proposed, then Weir 7 will need to be rebuilt. The new structure would need to be about 2 feet taller than the existing weir. The reconstruction of Weir 7 should include the repair of leaks that presently exist. One leak is under a rock near the overflow weir shown in Figure 15. Other leaks occur where concrete meets rock, but the most significant leaks occur where concrete sandbags were used in the original construction. Additionally, the existing overflow weir section should be replaced with a new weir so that flow through the lower fish ladder could be more closely regulated. The overflow weir, sandbag construction, and one of the leaks in Weir 7 are shown in Figure 15.



Figure 15. Weir 7 overflow at 24 cfs.

A benefit of reconstructing Weir 7 is that features can be incorporated into the new weir that may help to dewater the lower section of the fish ladder, especially the area around Pool 1. For example, an opening could be cast in the reconstructed weir so that a pipe or flume could be used to transport water downstream of the lower

section. Additionally, If the existing concrete sandbag wall section is removed, then much of Pools 7 and 8 would be dewatered, facilitating construction in these pools.

The other method for creating a head differential in this area would be to plug the tunnel through Weir Group 8. Unfortunately, without dewatering the site, it is difficult to determine the geologic makeup of this feature and the feasibility of this option. Two potential methods for blocking this tunnel include (1) filling it in with boulders from the upstream side, then sealing the voids with concrete or grout and (2) breaking up rock that forms the tunnel lid, dropping it into the void, and stabilizing the rocks using concrete or grout. Because of the uncertainty of these options, a more practical solution would be to construct a new weir in Pool 7.

TASK 3L-2 - Improve entrance conditions.

Task 3L-2 is needed for the reasons described in Task 2L-2.

PROPOSED WORK

Raise the water surface elevation in Pool 1 - This work could be done using the same methods described in Alternative 2, but the weir crest height equal to the height of the existing steel bar. The weir would not need to be as high as described in Alternative 2 because the height of Weir 2 would be lower.

TASK 3L-3 - Adjust drops between pools to 2 feet or less.

Task 3L-3 is important because under existing conditions, the drops between some pools are nearly 3 feet, which may cause passage difficulties for fish. By adjusting the heights of the weirs, the larger drops will be reduced while some of the smaller drops will be increased.

PROPOSED WORK

Cap the weir crests with steel set at predetermined elevations - Table 3 summarizes the required change in weir crest elevations from the existing mean crest elevation, assuming that the new weirs would be 3 feet wide. Table 4 summarizes existing and proposed relative elevation differences between consecutive weir crests.

Table 3. Proposed weir crest elevation changes and finished elevations for Task 3L-3.

Weir	Elevation Change (ft.)	Finished Elevation (ft.)
1	0	433.76
2	-0.48	435.57
3	+0.77	437.57
4	+0.55	439.57
5	-0.31	441.57
6	-0.40	443.57
7	0	445.57
8	New weir or +0.36	447.57

Table 4. Existing and proposed drops between pools for Task 3L-3.

Pools	Existing Drops (ft.)	Proposed Drops (ft.)
Creek WSEL to Pool 1	0.23	1.67
1 to 2	2.73	1.81
2 to 3	0.75	2.00
3 to 4	2.22	2.00
4 to 5	2.86	2.00
5 to 6	2.09	2.00
6 to 7	1.60	2.00
7 to 8	0 (at low flow)	2.00

Adjust weir crest length or type - Because the length of a weir crest will affect pool water surface elevation and hydraulics, an effort should be made to choose the appropriate length and type of weir repair. The previous discussion and tables apply to standard weirs with 3-foot-wide crests, but this is not the only possible type of weir that can be used (Sheet 10). Using vertical slot may be appropriate for some areas where swim-through conditions could exist or where adequate clearance is not available for fish to jump over weirs.

One advantage of using some type of vertical slot is that it may provide a “swim-through” condition for fish passage. This would probably not be the case, however, for Alternative 3 at a 10 cfs design flow. The deepest slot that could be used would be about 2 feet, making the slot invert the same elevation as the water surface of the downstream pool. This is because of both the fish ladder geometry and the limited capacity of the fish ladder. A 2-foot deep by 1-foot wide slot would pass about 10 cfs, but the flow may vary depending on the characteristics of the upstream pool. Unfortunately, we are constrained by the configuration of the existing pools, which vary significantly from one to the next in shape, size, and ability to dissipate energy. Each slot may need to be adjusted differently, most likely being custom sized and fitted using trial and error in the field, as described below (see Figure 16).

Another disadvantage of slots is their potential inability to maintain pool depths in the upstream pool. The deeper the slot, the shallower the water in the pool can become if flow conditions change. It is difficult to predict how slots will work hydraulically in combination with standard weirs. Changing conditions in pool would have a more dramatic effect on fish passage than a weir only system. For example, if the flow in the fish ladder dropped down to 5 cfs, the depth of flow in the slot would drop by about 0.8 foot and the depth of flow over the weir would drop by about 0.4 foot. If the slot is downstream of the weir, then the drop between pools could increase by 0.4 foot.

Slots are also more likely to be obstructed by debris passing down the fish ladder. A few sticks turned perpendicular to the flow could completely block fish passage. Additionally, slots do not act like weirs hydraulically and would pass more flow through a smaller area. For a 2-foot deep by 1-foot wide slot size, because of the decreased area, water velocities would be about 50 percent higher than with a standard weir at 10 cfs flow (3.3 fps for a weir, and 5 fps per slot).

One way to overcome the hydraulic uncertainty may be to construct a type of variable weir that can be configured as either a slot or a standard weir. To accomplish this, a 3-foot wide by 2.5-foot deep area could be cut out of the existing weir. This area only needs to be 2 feet deep, but making it deeper than the minimum requirement will allow flexibility to adjust invert elevations. This opening would be capped with steel and include flashboard type slots (Figure 16 A). This opening could then be fitted with inserts to create an adjustable slot (Figure 16 B), or with flashboards to create an adjustable weir (Figure 16 C). V-notch inserts (not shown) could also be used. V-notch weirs would probably create better fish ladder hydraulics than rectangular slots, but may not be as good for fish passage. These variable weirs could also be adapted to accept “chutes” or “ramps” that may provide more of a swim-through condition between pools. One drawback with this option is that few pools are large enough to use chutes or ramps without sacrificing energy dissipation.

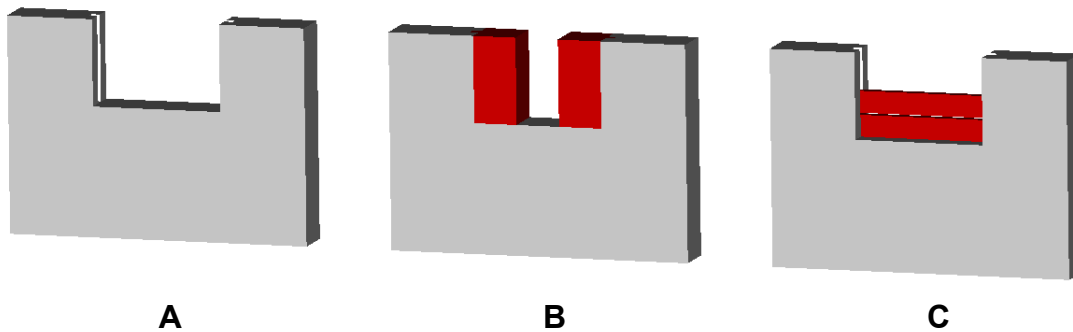


Figure 16. Variable weirs.

TASK 3L-4 - Excavate pools.

Task 3L-4 is important because some of the pools are shallow, possibly limiting a fish’s ability to leap from one pool to the next. Additionally, larger pools typically have the capacity to dissipate more energy. This can reduce the effort required by the fish to move from one pool to the next. It appears that in some of the lower pools, loose material could be excavated easily to increase pool volume. Some have clean bottoms, some contain sediment and cobbles, and some contain large rocks that should be removed or excavated. Figures 17 and 18 on the following page show some of the material in the bottom of Pools 5 and 6.

PROPOSED WORK

Excavate some pools to add depth for leaping and to improve energy dissipation - Table 5 summarizes excavation depth, the standards being met, and energy dissipation values for pools in the lower fish ladder section. DFG and NMFS have stated that for this project, the minimum pool depth required for fish to be able to jump from one pool to the next is 1.5 times the jump height. The minimum leaping depth standard is planned to be met, and the energy dissipation standard should be met where economically and geologically appropriate.



Figure 17. Sediment and cobbles in Pool 5.



Figure 18. Large rocks in Pool 6.

To meet this standard, Pools 2, 5, and 6 will need to be deepened. Keeping the pools clean so that they continue to meet the minimum leaping depth requirements will be the responsibility of the fishway operators. Pool depths are based on the assumption that the depth of flow over the downstream weir is 1 foot, or about 10 cfs for a 3-foot-wide weir.

Table 5. Proposed average excavation depth, pool floor elevation, and energy dissipation for 10 cfs with 2-foot drops between lower pools.

Pool (#)	Proposed Excavation (ft)	Finished Elevation (ft)	Standards Met		Energy Dissipation (ft-lb/ft ³ /sec)
			Leaping	Energy	
1	0	No Change	Yes	Yes	<=4
2	0.7	433.6	Yes	No	12.3
3	0.1	434.4	Yes	Yes	<=4
4	0.4	436.0	Yes	Yes	<=4
5	1.1	438.9	Yes	Yes	<=4
6	0.4	441.6	Yes	Yes	<=4
7	0	No Change	Yes	Yes	<=4
8	0	No Change	Yes	Yes	<=4

- Pool 2 would need to be deepened an average of 0.7 foot. Presently this pool has a concrete floor, but there is a void space under the floor of the ladder. To deepen the pool, the floor could be removed and the weir extended down to the creek bottom.
- Pools 5 and 6 should be deepened an average of 0.4 foot. These pools presently contain a thick layer of gravel and cobbles that can be excavated to gain the required pool depth.

The standard for energy dissipation for a step pool fish ladder is based on effective pool volume relative to the amount of water flowing through the structure and the head differential between consecutive pools. The standard is:

$$V_{\text{pool}} = 16 \times Q \times (\Delta h)$$

V_{pool} = required effective pool volume

Q = flow of water through pool in cfs

Δh = difference in water surface elevation between consecutive pools

Figure 19 illustrates energy dissipation values for standard pool and weir fish ladders at various published flow rates. The middle data points on each line depict the energy dissipation at the “normal” flow rate. The normal energy dissipation for each of the fish ladder sizes is about 4 ft-lb/ft³/sec, which is the accepted value. It appears, however, that somewhat larger values are sometimes accepted, especially for smaller sized fish ladders.

Because the required pool volume increases with flow, it is desirable to limit the amount of water entering the fish ladder. This could be accomplished by the construction of a new overflow weir as a part of Weir 7. To meet the energy standard with 10 cfs of flow (10 cfs = 1 foot of weir flow), Pools 2, 3, 4, and 5 would need to be enlarged. The following summarizes the required changes:

- Pool 2 – requires increased depth and length
- Pool 3 – widen by 0.1 foot
- Pool 4 – excavate by 0.4 foot
- Pool 5 – excavate by 1.1 feet

Approximate Energy Dissipation Values For Three Standard Sized Pool and Weir Fish Ladders At Various Flows. From Fisheries Handbook (Bell)

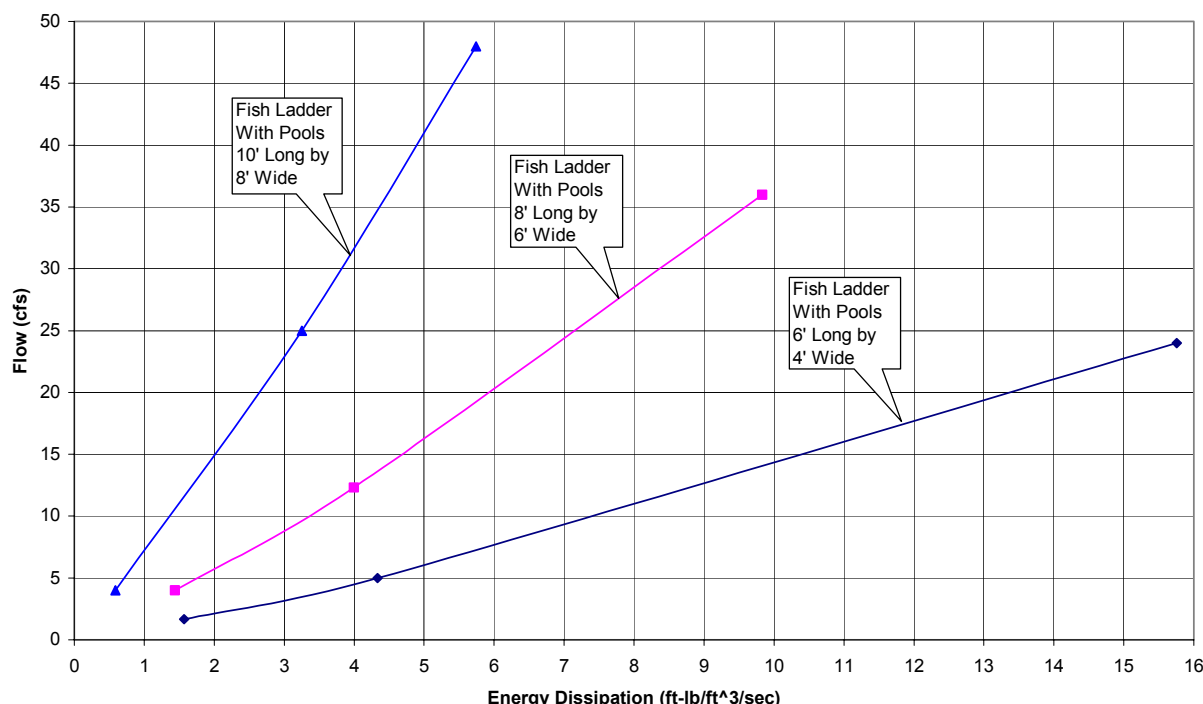


Figure 19. Energy dissipation chart.

Modifying Pool 2 may not be feasible. To get the proper volume, Pool 2 would need to be deepened, lengthened, and/or slightly widened. Unfortunately, large boulders confine this pool, and increasing its size would be quite difficult. Being able to meet the energy dissipation standard would involve excavating large boulders that would affect numerous boulders in the same area. This would add significantly to the cost of the project.

Pool 3 has a concrete floor, so its depth will not be increased. Its right-side wall must be rebuilt, so this wall will be moved slightly outward.

This task would be relatively easy for Pools 4 and 5 because minimal excavation is required. The required excavation for Pool 5 is actually only 0.7 foot more than the excavation required to meet the leaping standard.

It may not be possible to dissipate the energy of flows higher than 10 cfs and still use the existing facilities. If the flow increases to 18 cfs (1.5-foot-deep weir flow), then the required pool volume would be increased from 320 cubic feet to 576 cubic feet. The existing pools cannot be enlarged this much under this alternative.

Another issue that should be addressed is pool stability. Some of the pools in the fishway have a history of having their natural or concrete floors “drop out.”

Seasonal flows and dynamic changes in the creek have caused movement of gravels, sediment, or rock that in turn have caused some pools to leak. The entire fishway is constructed on boulders of various sizes; and the pool floors are sealed with gravels, sediment, and/or concrete. Pools that will be modified should also be stabilized with a slurry fill or concrete to prevent leaking.

Upper Section

For the upper section, Alternative 3 involves 4 tasks:

- 3U-1 Repair existing damaged concrete structures.
- 3U-2 Improve exit conditions.
- 3U-3 Adjust drops between pools to 2 feet or less.
- 3U-4 Excavate pools.

TASK 3U-1 - Repair existing damaged concrete structures.

Task 3U-1 is needed for the reasons described in Task 2U-1.

PROPOSED WORK

The proposed work for this task includes all the items from Alternative 2 - One difference between Task 3U-1 and 2U-1 is that the weir heights would be adjusted and variable type weirs incorporated where appropriate. Task 3L-3 describes utilizing variable type weirs while Task 3U-3 describes adjusting weir heights. It may be easier in some cases to replace weirs instead of modifying their height.

TASK 3U-2 - Improve exit conditions.

Task 3U-2 is needed for the reasons described in Task 2U-2.

PROPOSED WORK

The proposed work for this alternative is similar to Task 2U-2 - One additional feature proposed in this alternative is the stabilization of the floor of the headpool.

The floor of the headpool dropped out in the past and had to be manually refilled with local streambed materials. A permanent fix, such as building a concrete floor, should be done at this location. This area should be dewatered and inspected to look for foundation materials suitable for this structure.

The concrete bag wall at the fish ladder exit should be reconstructed. This wall seals a leak in one of the walls of the headpool but is in poor condition.

TASK 3U-3 - Adjust drops between pools to 2 feet or less.

Task 3U-3 is important because under existing conditions, the drops between pools are quite large. One is almost 4 feet, which may cause passage difficulties for fish. By adjusting the heights of the weirs, the larger drops can be reduced by increasing some of the smaller drops.

PROPOSED WORK

Cap the weir crests with steel set at predetermined elevations - Table 6 summarizes the required change in weir crest elevations and finished elevations. Table 7 summarizes existing and proposed relative elevation differences between consecutive weir crests.

Adjust weir crest lengths or type - This, and the possible use of variable weirs, has been described previously in Task 3L-3.

Table 6. Proposed weir crest elevation changes for Task 3U-3.

Weir	Elevation Change (ft.)	Finished Elevation (ft.)
9	+0.01	449.57
10	-0.09	451.57
11	-0.98	453.57
12	-0.53	455.57
13	-0.89	457.57
14	-0.84	459.57
15	-0.48	461.32
16	+0.25	463.07
17	+0.01	464.82

Table 7. Existing and proposed drops between pools for Task 3U-3.

Pools	Existing Drops (ft.)	Proposed Drops (ft.)
8 to 9	2.35	2.00
9 to 10	2.10	2.00
10 to 11	2.89	2.00
11 to 12	1.55	2.00
12 to 13	2.36	2.00
13 to 14	1.95	2.00
14 to 15	1.39	1.75
15 to 16	1.02	1.75
16 to 17 (Creek WSEL)	1.99	1.75

TASK 3U-4 - Excavate pools.

Task 3U-4 is important because some of the pools are not very deep, limiting a fish's ability to leap from one pool to the next. Additionally, larger pools typically have the capacity to dissipate more energy, which reduces the amount of energy required by the fish to move from one pool to the next.

PROPOSED WORK

Excavate some pools to add depth for leaping and to decrease energy dissipation - Leaping depth and energy dissipation are separate standards and, ideally, both would be met. We suggest, however, that the minimum leaping depth standard must be met, and the energy dissipation standard should be met where economically and geologically feasible. Table 8 summarizes excavation depths and energy dissipation for pools in the upper fish ladder section. The proposed excavation

corresponds to the minimum amount required for either leaping depth or for energy dissipation (see table and explanations below).

Table 8. Proposed average excavation depth, pool floor elevation, and energy dissipation for 10 cfs with 2-foot drops between upper pools.

Pool (#)	Proposed Excavation (ft)	Finished Elevation (ft)	Standards Met		Energy Dissipation (ft-lb/ft ³ /sec)
			Leaping	Energy	
9	1.0	445.8	Yes	No	5.6
10	0.0	No Change	Yes	Yes	<=4
11	2.1	451.4	Yes	Yes	<=4
12	0.0	No Change	Yes	No	6.1
13	1.3	455.6	Yes	Yes	<=4
14	0.9	457.9	Yes	No	7.4
15	1.3	459.7	Yes	No	6.4
16	0.3	461.4	Yes	No	4.3

To meet the minimum pool depth standard for leaping, Pools 11, 13, 14, 15, and 16 must be deepened. Keeping the pools clean so they continue to meet the minimum depth requirements will be the responsibility of the fishway operator.

- Pool 11 needs to be deepened by an average of 2.1 feet because it is presently only about 1.9 feet deep, and the downstream weir is proposed to be lowered by 0.98 foot. Presently, Pool 11 contains an unknown amount of loose materials. Because Weir 11 is almost 9 feet high on the downstream side, the loose material is expected to be relatively thick. To test the depth, DWR personnel performed some exploratory work with a steel bar in this pool (and others) on September 26, 2000. Based on this work, it is believed that 2.1 feet of material can be excavated from this pool.
- Pool 13 needs to be deepened an average of about 1.3 feet. It is also desirable to enlarge this pool to turn it into a large resting pool for fish. The upper ladder does not currently have any large resting pools that would allow fish to rest before making the final run through the remaining portion of the fish ladder. Some sections of the pool exceed the required minimum leaping depth, and excavation of rocks and sediment to bring the entire pool into compliance can be achieved.
- Pool 14 needs to be deepened by at least 0.9 foot. Inspection of this pool indicated that it should be relatively easy to increase the depth by 1 or 2 feet, which is more desirable for greater energy dissipation.
- Pool 15 needs to be deepened by 1.3 feet. Inspection of this pool indicated that it should be relatively easy to increase the depth by 1 foot. Additional excavation beyond this depth may be more difficult.
- Pool 16 needs to be deepened an average of about 0.3 foot. Some portions of this pool exceed the depth requirement, but the area immediately downstream of the exit weir does not. This area should be excavated; however, inspection of the pool revealed that the floor is made up of primarily large, in-place boulders that will make excavation difficult.

To meet the energy dissipation standard for 10 cfs, Pools 9, 12, 13, 14, 15, and 16 must be enlarged. The sidewalls of the upper section of the fish ladder are primarily large boulders, and the floors are made up of some loose material and some large boulders. To gain the required energy dissipation, this increase in area could be obtained by excavating either the floors or the side- walls (where appropriate) of the fish ladder weirs. Increases will be described as an average excavation of the pool floor, although any excavation could be a combination of both floors and walls. This would be determined in the final design phase or during construction. Following are the required changes:

- Pool 9 – excavate by 3.1 feet.
- Pool 12 – excavate by 2.2 feet.
- Pool 13 – will meet the energy dissipation standard with proposed excavation, but this pool should be further enlarged, if possible, to create a larger resting pool.
- Pool 14 – excavate 3.1 feet more than required by the leaping standard 4.0 feet,
- Pool 15 – excavate 2.3 feet more than required by the leaping standard 3.6 feet,
- Pool 16 – excavate 2.9 feet more than required by the leaping standard 3.2 feet,

Since the upper section of the ladder is a long run, it is proposed that Pool 13 be enlarged beyond the energy dissipation standard, if feasible, to make this pool as large as possible to create a large resting area for the fish. This is the only pool in the upper section that can be enlarged without excavating into large boulders that make up a major portion of the fish ladder; however, excavation of any given pool should not stop at the minimum leaping depth if additional excavation is easily achievable.

It may not be possible to dissipate the energy of flows higher than 10 cfs and still use the existing facilities. If the flow increases to 18 cfs (1.5-foot-deep weir flow), then the required pool volume would increase from 320 cubic feet to 576 cubic feet. The existing pools cannot be enlarged this much.

Pools 14, 15, and 16 are in the tunnel section of the fish ladder (Figure 10). It is likely that the roof in this area will need to be stabilized before work can proceed.

Maintenance

To keep the fishway proposed in Alternative 3 operating as intended, regular maintenance, adjustments, and minor repairs or maintenance will be required. Significant work could be required if changes in creek flows cause portions of the fishway to become ineffective. At creek flows of more than about 100 cfs, maintenance and adjustments may not be possible. This may limit the time that work can be performed to the late spring through fall months.

Regular maintenance work will include inspection of the entire fishway to ensure proper operation and sediment and debris removal. Work will also include adjustments to the fishway exit to maintain the proper amount of water flowing into the fish ladder as the creek stage changes at the fish ladder exit. Individual weirs will also need periodic adjustments.

Less frequent, but more significant work may include repair of damaged concrete structures, sealing leaks, and pool excavations. Major work may be required because of changes in channel hydraulics or geologic conditions. These types of changes have resulted in significant work in the past. Presently, this site is only accessible by foot. Thus, specialized equipment, such as a crane or helicopter, may be required when significant repairs are done.

An operations and maintenance manual should be developed during the final design process to provide information on how the fish ladder should be operated and maintained.

Table 9. Iron Canyon Alternative 3 preliminary cost estimate.

**Big Chico Creek - Iron Canyon Fish Passage Project
Preliminary Cost Estimate for Design and Construction
Alternative 3**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
<u>MISCELLANEOUS</u>					
1	Mobilization/Demobilization	1	LS	\$ 44,000	\$ 44,000
2	Site Work, Access & Mitigation	1	LS	\$ 27,000	\$ 27,000
3	Construction Scaffolding	1	LS	\$ 3,500	\$ 3,500
					\$ 74,500
<u>FISH LADDER LOWER SECTION</u>					
4	Weir Repair, Weir 1	1	LS	\$ 2,500	\$ 2,500
5	Weir Repair, General	8	EA	\$ 1,500	\$ 12,000
6	Weir Replacement, Weir 7	36	CY	\$ 1,000	\$ 36,000
7	New Weir in Pool 7 Near Weir 6	10	CY	\$ 1,000	\$ 10,000
8	Pool 3 Floor Repair	1	LS	\$ 1,000	\$ 1,000
9	Pool Leak Repair, General	1	LS	\$ 1,500	\$ 1,500
10	Excavation - Concrete	16	CY	\$ 500	\$ 8,000
11	Excavation - Rock	120	CY	\$ 350	\$ 42,000
12	Concrete (Walls & Baffles)	4	CY	\$ 1,000	\$ 4,000
13	Armor/Strengthen Walls (Pool 3)	1	LS	\$ 5,500	\$ 5,500
14	Dewatering	30	DAY	\$ 2,500	\$ 75,000
					\$ 197,500
<u>FISH LADDER UPPER SECTION</u>					
15	Weir Repair, General	9	EA	\$ 1,500	\$ 13,500
16	Pool 10 Repair	1	LS	\$ 5,000	\$ 5,000
17	Pool Leak Repair	1	LS	\$ 1,500	\$ 1,500
18	Exit Structure (Weir 17)	1	LS	\$ 6,500	\$ 6,500
19	Stabilize Headpool and Tunnel	15	CY	\$ 1,000	\$ 15,000
20	Excavation - Concrete	2	CY	\$ 500	\$ 1,000
21	Excavation - Rock	20	CY	\$ 500	\$ 10,000
22	Concrete (Walls & Baffles)	4	CY	\$ 1,000	\$ 4,000
23	Dewatering	30	DAY	\$ 1,300	\$ 39,000
					\$ 95,500
24	Construction Cost				\$ 367,500
25	Contingency @ 30%				\$ 110,500
26	Construction Cost Subtotal				\$ 478,000
27	Engineering				\$ 78,000
28	Environmental				\$ 13,000
29	Construction Inspection				\$ 52,000
30	Contract Administration				\$ 39,000
31	Total				\$ 660,000

ALTERNATIVE 4 - Major Improvements (1.5-foot drops)

Lower Section

For the lower section, Alternative 4 involves 4 tasks:

- 4L-1 Repair existing damaged concrete structures.
- 4L-2 Improve entrance conditions.
- 4L-3 Adjust drops between pools to 1.5 feet or less.
- 4L-4 Excavate pools.

TASK 4L-1 - Repair existing damaged concrete structures.

Task 4L-1 is important for all of the reasons listed earlier in this document under Tasks 2L-1 and 3L-1.

PROPOSED WORK

Repair existing concrete - This task consists of the same work proposed in Task 3L-1.

TASK 4L-2 - Improve entrance conditions.

Task 4L-2 is important for all of the reasons listed earlier in this document under Tasks 2L-2 and 3L-2.

PROPOSED WORK

Improve entrance conditions - This task consists of the same work proposed in Task 3L-2.

TASK 4L-3 - Adjust drops between pools to 1.5 feet or less.

Task 4L-3 is important to reduce drops to 1.5 feet to improve fish passage.

PROPOSED WORK

Rebuild/repair and add new weirs - These weirs should be capped with steel and set at predetermined elevations. This alternative is based on holding the water surface elevation of Pool 16 at its present level and working downstream to create equal 1.5-foot weir crest elevation differences. Table 10 on the following page summarizes the required changes in weir crest elevations based on the existing mean crest elevation and 3-foot- wide weir crests. Table 11 summarizes existing and proposed relative elevation differences between consecutive weir crests. This alternative would require the following new structures:

- 1) Head dissipation structure in pool 1 designed to dissipate about 0.75 foot of head.
- 2) New weir in Pool 5.
- 3) New weir in Pool 6.
- 4) New weir in Pool 7 near the right bank.
- 5) New weir in Pool 8, or repair of Weir 8, or a second new weir in Pool 7.

Table 10. Proposed weir crest elevation changes and finished elevations for Task 4L-3.

Weir	Elevation Change (ft.)	Finished Elevation (ft.)
1	-0.19	433.76
1B	New	Use boulders to raise upstream WSEL 0.75'
2	-0.23	435.82
3	+0.52	437.32
4	-0.20	438.82
5	-1.56	440.32
5B	New	441.82
6	-0.65	443.32
6B	New	444.82
7	+0.75	446.32
7B	New	447.82
7C, 8, or 8B	New weir or +2.11	449.32

Table 11. Existing and proposed drops between pools for Task 4L-3.

Pools	Existing Drops (ft.)	Proposed Drops (ft.)
Creek WSEL to Pool 1	0.23	1.50
1 to 1B	0	0.75
1B to 2	2.73	1.50
2 to 3	0.75	1.50
3 to 4	2.22	1.50
4 to 5	2.86	1.50
5 to 5B	0	1.50
5B to 6	2.09	1.50
6 to 6B	0	1.50
6B to 7	1.60	1.50
7 to 7B	0	1.50
7B to 8	0 (at low flow)	1.50

- The proposed head dissipation structure in Pool 1 would be a couple of large boulders placed in the pool and rock-bolted in place. The exact size and number will need to be determined by trial.
- The proposed new weirs in Pools 5 and 6 should be placed in a convenient location near the center of the pools. These pools are relatively large and the addition of new weirs should not adversely affect pool hydraulics.
- The proposed new weir near the right bank of Pool 7 is the same structure described in Task 3L-1 and is labeled "C" in Figure 14.
- The last new feature required in the lower section of the fish ladder is another structure to dissipate 1.5 feet of head. This could be a second new weir in Pool 7, repair of Weir 8, or a new weir in Pool 8. At this time, there is no good way to select the best location for this structure because Pools 7 and 8 are relatively deep and filled with sediment. These pools need to be dewatered and inspected to find a site

with suitable foundation material. This can be done during construction and the best option chosen at that time. If a new weir is constructed in Pool 8, the existing overflow weir within Weir 7 should be blocked, and the underwater tunnel (labeled “A” in Figure 14) will become the primary fish passage route between Pools 7 and 8.

Adjust weir crest lengths or types as described in Task 3L-3.

TASK 4L-4 - Excavate pools.

Task 4L-4 is important because depth and pool volume are required for proper energy dissipation and to give fish enough area to leap from one pool to the next. This is not as much an issue for this alternative as it is for Alternative 3 because the head differential is smaller, so less energy will be transferred between pools, and the fish will not need to leap as high.

PROPOSED WORK

Increase pool volume - After inspection, it appears that some of the lower pools could be excavated to increase pool volume. Some pool bottoms are clean, some contain sediment, and some contain large rocks that can probably be removed or excavated, see Figures 17 and 18. Pool excavation could apply to the sidewalls, the floors, or both. Table 12 summarizes the proposed excavation depth and energy dissipation values for pools in the lower fish ladder section. The discussion about minimum pool depth for Task 3L-4 also applies to this alternative.

Table 12. Proposed average excavation depth, pool floor elevation, and energy dissipation for 10 cfs with 1.5-foot drops between pools.

Pool (#)	Proposed Excavation (ft)	Finished Elevation (ft)	Standards Met		Energy Dissipation (ft-lb/ft ³ /sec)
			Leaping	Energy	
1	0	No Change	Yes	Yes	<=4
1B	0	No Change	Yes	Yes	<=4
2	0.7	433.6	Yes	No	8.5
3	0.1	434.4	Yes	Yes	<=4
4	0.4	436.0	Yes	Yes	<=4
5	1.1	438.9	Yes	No	4.8
5B	1.1	438.9	Yes	No	4.5
6	0.4	441.6	Yes	Yes	<=4
6B	0.4	441.6	Yes	Yes	<=4
7	0	No Change	Yes	Yes	<=4
7B	0	No Change	Yes	Yes	<=4
8 or 8B	0	No Change	Yes	Yes	<=4

Upper Section

For the upper section, Alternative 4 involves 4 tasks:

- 4U-1 Repair existing damaged concrete structures
- 4U-2 Improve exit conditions
- 4U-3 Adjust drops between pools to 1.5 feet or less.
- 4U-4 Excavate pools

Task 4U-1 - Repair existing damaged concrete structures.

Task 4U-1 is important for all of the reasons described earlier in Tasks 2U-1 and 3U-1 pertaining to repairing damaged structures.

PROPOSED WORK

The proposed work for this task includes all of the items from Alternative 2, Task 2U-1 - One difference between Tasks 4U-1 and 2U-1 is that the weir heights would be adjusted and variable type weirs incorporated where appropriate. Task 3L-3 and 4L-3 describes utilizing various weir types while Task 4U-3 describes adjusting weir heights. It may be easier in some cases to replace weirs instead of modifying their height.

Task 4U-2 - Improve exit conditions.

Task 4U-2 is important for the reasons listed earlier in Tasks 2U-2 and 3U-2 pertaining to improving exit conditions.

PROPOSED WORK

The proposed work for this alternative is the same as for Task 2U-2.

Task 4U-3 - Adjust drops between pools to 1.5 feet or less.

Task 4L-3 would be important if it is decided that having 2-foot drops between pools is not sufficient to provide the desired level or ease for fish passage.

PROPOSED WORK

Rebuild/repair and add new weirs - These weirs should be capped with steel and set at predetermined elevations. This alternative is based on holding the water surface elevation of Pool 16 at its current level and working downstream to create equal 1.5-foot weir crest elevation differences. Table 13 on the following page summarizes the required changes in weir crest elevations based on the existing mean crest elevation. Table 14 summarizes existing and proposed relative elevation differences between consecutive weir crests. For the upper section of the fish ladder, this alternative would require a new weir to be constructed in Pool 12.

Construct a new weir in Pool 12 - This weir could be constructed in Pool 11, 12, or 13, but Pool 12 is the best choice. Pool 12 is slightly longer than Pool 11, and Pool 13 is planned to be enlarged to become a resting pool. Constructing a new weir at this location significantly increases the energy in the two new pools formed by this structure, but this may be unavoidable.

Adjust the weir crest length and type - Slots and variable weirs were discussed in Task 3L-3. While these slots may not be appropriate for Alternative 3, they probably are appropriate for at least a couple of areas in Alternative 4. The main difference is that with 2-foot deep slots and 1.5-foot head differentials, slots may create a swim-through condition for fish. This may be an important condition to have in some areas, especially at Weir 10. This alternative requires that Weir 10 be raised by about 0.7 foot. This would force the water surface to within about 0.8 foot of the rock ceiling over the weir and may cause problems for leaping fish. If Weir 10 is converted to slots, then Weir 9 should also be a slot to maintain similar hydraulics in this area.

Table 13. Proposed weir crest elevation changes for Task 4U-3.

Weir	Elevation Change (ft.)	Finished Elevation (ft.)
9	+1.26	450.82
10	+0.66	452.32
11	-0.73	453.82
12	-0.78	455.32
12B	New	456.82
13	-0.15	458.32
14	-0.59	459.82
15	-0.48	461.32
16	0	462.82
17	-0.49	464.32

Table 14. Existing and proposed drops between pools for Task 4U-3.

Pools	Existing Drops(ft.)	Proposed Drops(ft.)
8 to 9	2.35	1.50
9 to 10	2.10	1.50
10 to 11	2.89	1.50
11 to 12	1.55	1.50
12 to 13	2.36	1.50
13 to 14	1.95	1.50
14 to 15	1.39	1.50
15 to 16	1.02	1.50
16 to 17 (Creek WSEL)	1.99	1.50

Task 4U-4 - Excavate pools.

Task 4U-4 is important because some of the pools are not deep enough to allow fish to leap from one pool to the next. Additionally, larger pools have the capacity to dissipate more energy, reducing the amount of energy required by the fish to move from one pool to the next.

PROPOSED WORK

Excavate some pools to add depth for leaping and to improve energy dissipation - Leaping depth and energy dissipation are separate standards and ideally both will be met. We suggest, however, that the minimum leaping depth standard must be met, and the energy dissipation standard should be met where economically and

geologically feasible. Table 15 summarizes excavation depths and energy dissipation for pools in the upper fish ladder section. The proposed excavation corresponds to the minimum amount required for either leaping depth or energy dissipation as described in Task 3U-4. These excavation depths should be considered the minimum depth. Further excavation should be performed where economically and geologically feasible.

Table 15. Proposed average excavation depth, pool floor elevation, and energy dissipation for 10 cfs with 1.5-foot drops between pools.

Pool (#)	Proposed Excavation (ft)	Finished Elevation (ft)	Standards Met		Energy Dissipation (ft-lb/ft ³ /sec)
			Leaping	Energy	
9	1.0	445.8	Yes	Yes	<=4
10	0	No Change	Yes	Yes	<=4
11	2.1	451.4	Yes	Yes	<=4
12	0	No Change	Yes	No	10.2
12B	0	No Change	Yes	No	8.1
13	1.3	455.6	Yes	Yes	<=4
14	0.9	457.9	Yes	No	5.8
15	1.3	459.7	Yes	No	5.5
16	0.3	461.4	Yes	No	5.9

Maintenance

To keep the fishway proposed in Alternative 4 operating as intended, regular maintenance will be required. Adjustments and minor repairs or maintenance could be needed frequently. Significant work may be required more often if changes in creek flows cause portions of the fishway to become ineffective. At creek flows of more than about 100 cfs, maintenance and adjustments may not be possible. This may limit the time that work can be performed to the late spring through early fall months.

Regular maintenance will include inspection of the entire fishway to ensure proper operation and sediment and debris removal. Work will also include adjustments to the fishway exit to maintain the proper amount of water flowing into the fish ladder as the creek stage changes at the fish ladder exit. Individual weirs will also need periodic adjustments.

Less frequent, but more significant work may include repair of damaged concrete structures, sealing leaks, and pool excavations. Major work may be required because of changes in channel hydraulics or geologic conditions. These types of changes have resulted in significant work in the past. Presently, this site is only accessible by foot, so specialized equipment, such as a crane or helicopter, may be required when significant repairs are done.

An operations and maintenance manual should be developed during the final design process to provide information on how the fish ladder should be operated and maintained.

Table 16. Iron Canyon Alternative 4 preliminary cost estimate.

**Big Chico Creek - Iron Canyon Fish Passage Project
Preliminary Cost Estimate for Design and Construction
Alternative 4**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
<u>MISCELLANEOUS</u>					
1	Mobilization/Demobilization	1	LS	\$ 50,000	\$ 50,000
2	Site Work, Access & Mitigation	1	LS	\$ 30,000	\$ 30,000
3	Construction Scaffolding	1	LS	\$ 4,000	\$ 4,000
					\$ 84,000
<u>FISH LADDER LOWER SECTION</u>					
4	Weir Repair, Weir 1	1	LS	\$ 2,500	\$ 2,500
5	Weir Repair, General	8	EA	\$ 1,500	\$ 12,000
6	Weir Replacement, Weir 7	36	CY	\$ 1,000	\$ 36,000
7	New Weir in Pool 7 Near Weir 6	10	CY	\$ 1,000	\$ 10,000
8	New Weirs in Pools 1, 5, 6, and 8	36	CY	\$ 1,000	\$ 36,000
9	Pool 3 Floor Repair	1	LS	\$ 1,000	\$ 1,000
10	Pool Leak Repair, General	1	LS	\$ 1,500	\$ 1,500
11	Excavation - Concrete	17	CY	\$ 500	\$ 8,500
12	Excavation - Rock	120	CY	\$ 350	\$ 42,000
13	Concrete (Walls & Baffles)	7	CY	\$ 1,000	\$ 7,000
14	Armor/Strengthen Walls (Pool 3)	1	LS	\$ 5,500	\$ 5,500
15	Dewatering	30	DAY	\$ 2,500	\$ 75,000
					\$ 237,000
<u>FISH LADDER UPPER SECTION</u>					
16	Weir Repair, General	9	EA	\$ 1,500	\$ 13,500
17	New Weir in Pool 12	2	CY	\$ 1,000	\$ 2,000
18	Pool 10 Repair	1	LS	\$ 5,000	\$ 5,000
19	Pool Leak Repair	1	LS	\$ 1,500	\$ 1,500
20	Exit Structure (Weir 17)	1	LS	\$ 6,500	\$ 6,500
21	Stabilize Headpool and Tunnel	15	CY	\$ 1,000	\$ 15,000
22	Excavation - Concrete	2	CY	\$ 500	\$ 1,000
23	Excavation - Rock	20	CY	\$ 450	\$ 9,000
24	Concrete (Walls & Baffles)	3	CY	\$ 1,000	\$ 3,000
25	Dewatering	30	DAY	\$ 1,300	\$ 39,000
					\$ 95,500
26	Construction Cost				\$ 416,500
27	Contingency @ 30%				\$ 125,000
28	Construction Cost Subtotal				\$ 541,500
29	Engineering				\$ 92,000
30	Environmental				\$ 13,000
31	Construction Inspection				\$ 52,000
32	Contract Administration				\$ 39,000
33	Total				\$ 737,500

Iron Canyon Design and Construction Summary

Site Conditions and Assumptions

The preliminary drawings and layouts contained in this report will be refined during the final design process. Additional surveys, hydraulic analyses, and geologic explorations may be necessary because of changes in the site conditions since this investigation was conducted and to gain additional information that will be required for final design.

Codes and Standards

Final Designs will be governed by the following criteria:

- Final structural designs will comply with the latest Uniform Building Code requirements.
- Final concrete designs will comply with the latest American Concrete Institute Building Code Requirements for Reinforced Concrete Design.
- All current applicable CalOSHA safety standards will be met.
- All environmental permit conditions will be met.

Final Design Instructions

Final designs will adhere to the following directives:

- A complete operations and maintenance manual will be completed prior to project completion.
- The elevations shown for Iron Canyon are based on NAVD 88 Datum. Descriptions and elevations of control points can be obtained from ND.
- Actual concrete thickness, foundation requirements, and reinforcement requirements will be determined by the final design engineer.
- Excavation of the existing fish ladder pools should be limited to prevent leaks within a pool. Any leaks within existing floors and those created during construction will be sealed.

Construction Summary

At the Iron Canyon site, no improvements to the existing access roads leading to the north rim are proposed. The canyon rim rises about 200 feet above the main creek channel. Personnel access to the canyon floor is currently provided by a foot trail that begins at the Salmon Hole parking area and a second steeper trail that originates between Salmon Hole and the Iron Canyon project site. There is no access from the south canyon rim. Staging areas would exist on the north rim.

Since there is no road access leading to the project site, it is anticipated that a crane, highline, and/or helicopter will be used. Construction of an access road leading to the creek is not feasible. The limits of the staging areas and access routes should be marked and managed to prevent vehicular or personnel access outside of the

designated zone. A small storage area will be needed on the north canyon rim to store a small amount of equipment and fuels.

Temporary cofferdams, flumes, pipes, and pumps may be used in the project area for dewatering purposes. Gravel and concrete, excluding any steel that is excavated in the project area should remain on site where it will not interfere with the operation of the fish ladder or cause negative environmental impacts.

Bear Hole

Summary of Findings

Comparison of Viable Alternatives

Alternative 2 – Enlarge Constriction Areas.

Cost Estimate

\$ 131,500

- Excavate rock in the upper constriction area to open up the passage corridor.
- Investigate excavating the lower constriction area that exists immediately downstream.
- Ensure that the creek bed above the modifications is stabilized.

Alternative 3 – Enlarge Constriction area and Add Gradient Control Structures.

Cost Estimate

\$ 138,000

- Excavate rock in the upper constriction area to open up the passage corridor.
- Ensure that the creek bed above the modification is stabilized.
- Add two gradient control structures downstream of the constriction area to provide gradual steps past the constriction area.

Alternative 4 – Add Gradient Control Structures.

Cost Estimate

\$ 137,000

- Add two gradient control structures downstream of the constriction areas to provide gradual steps past the constriction areas.

Advantages and Disadvantages

The main advantage of Alternative 2 is that the section of creek in the vicinity of the constriction areas would be repaired and would improve fish passage without construction of any new structures. Once the sections of creek near the constriction areas are reshaped, this stretch of creek should remain stable and provide good fish passage.

The main disadvantage of Alternative 2 is that a potentially large area of the existing creek could be disturbed when enlarging the upper constriction area. Numerous boulders upstream of the upper constriction area will likely need to be moved, removed, or stabilized. If the creek bed upstream of the constriction is not stabilized, fish passage problems may develop in the area.

The main advantage of Alternative 3 is that improved fish passage is gained, and the project would not disturb a significant amount of existing creek bed. The gradient control structures would provide steps for passage beyond the upper constriction area.

Probably only a small amount of excavation at the constriction area itself would be needed.

The main disadvantage of Alternative 3 is that new structures would be introduced into this natural site. The deeper pools created may also draw swimmers to the area, which could cause delays in fish passage.

The main advantage of Alternative 4 is that improved fish passage would be gained, and the project would not disturb a significant amount of the existing creek bed. The gradient control structures would provide steps for passage beyond the upper constriction area and no excavation would be required.

The main disadvantage of Alternative 4 is that new structures would be introduced into this natural site. The deeper pools created may also draw swimmers to the area, which could cause delays in fish passage.

Conclusion and Recommendations

The technical team decided Alternative 4 is the preferred alternative. The construction of 2 gradient control structures will improve fish passage without creating creek bed instability above the upper constriction area. The fisheries agencies thought that constructing two structures that would provide approximately 1.5-foot drops is preferred over constructing a single structure that would provide approximately 2-foot drops. Over time, the gradient control structures will accumulate sediment and bedload behind them. This will help to create a more constant slope in the creek bed in this area.

ALTERNATIVE 2 - Enlarge Constriction Area

This alternative involves enlarging the constriction area that contributes to the excessive water surface and existing ground elevation differential. The tasks involved would be:

- Excavate the rock at the upper constriction area to open up the passage corridor.
- Consider excavating the lower constriction area that exists immediately downstream.
- Ensure that the creek bed above the modifications is stabilized.



Figure 20. Bear Hole upper constriction area (Looking upstream).



Figure 21. Bear Hole lower constriction area (Looking downstream).

PROPOSED WORK

The boulders that create an excessive headwater/tailwater difference would be excavated to open up a cross section of the constricted area. The work would involve modifying the upper right portion of a large boulder (see Figure 20).

Additional excavation at the lower constriction area immediately downstream would also be done. This would open up the cross sectional area through what is believed to be the main fish passage route.

Additional work that may be needed is to stabilize the creek bed immediately upstream of the constriction areas. Depending on the amount of excavation, instability of the creek bed is likely because of downcutting and material movement in the channel. Basalt boulders of various sizes, along with sediment and bedload existing within the creek, are susceptible to movement. This would need to be closely monitored during and after construction to ensure that the excessive head differential that exists now does not migrate upstream.

Maintenance

This alternative would require no maintenance other than an occasional inspection to ensure that the creek bed is stable.

Table 17. Bear Hole Alternative 2 preliminary cost estimate.

**Big Chico Creek - Bear Hole Fish Passage Project
Preliminary Cost Estimate for Design and Construction
Alternative 2**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
<u>MISCELLANEOUS</u>					
1	Mobilization/Demobilization	1	LS	\$ 3,000	\$ 3,000
2	Site Work, Access, & Mitigation	1	LS	\$ 2,500	\$ 2,500
3	Dewatering	1	LS	\$ 10,000	\$ 10,000
					\$ 15,500
<u>CONSTRUCTION</u>					
4	Excavation - Rock	10	CY	\$ 300	\$ 3,000
5	Channel Stabilization	80	CY	\$ 300	\$ 24,000
					\$ 27,000
6	Construction Cost				\$ 42,500
7	Contingency @ 25%				\$ 11,000
8	Construction Cost Subtotal				\$ 53,500
9	Engineering				\$ 26,000
10	Environmental				\$ 13,000
11	Construction Inspection				\$ 13,000
12	Contract Administration				\$ 26,000
13	Total				\$ 131,500

ALTERNATIVE 3 - Enlarge the Constriction Area and Add Gradient Control Structures

This alternative involves enlarging the constriction area that contributes to the excessive water surface and existing ground elevation differential. A gradient control structure(s) downstream of the constriction area would be installed to raise the tailwater to make passage easier at the existing constriction areas. The tasks involved would be:

- Excavate rock at the upper constriction area to open up a passage corridor.
- Ensure that the creek bed above the modification is stabilized.
- Add a gradient control structure(s) downstream of the constriction area to provide a gradual step(s) past the constriction area.

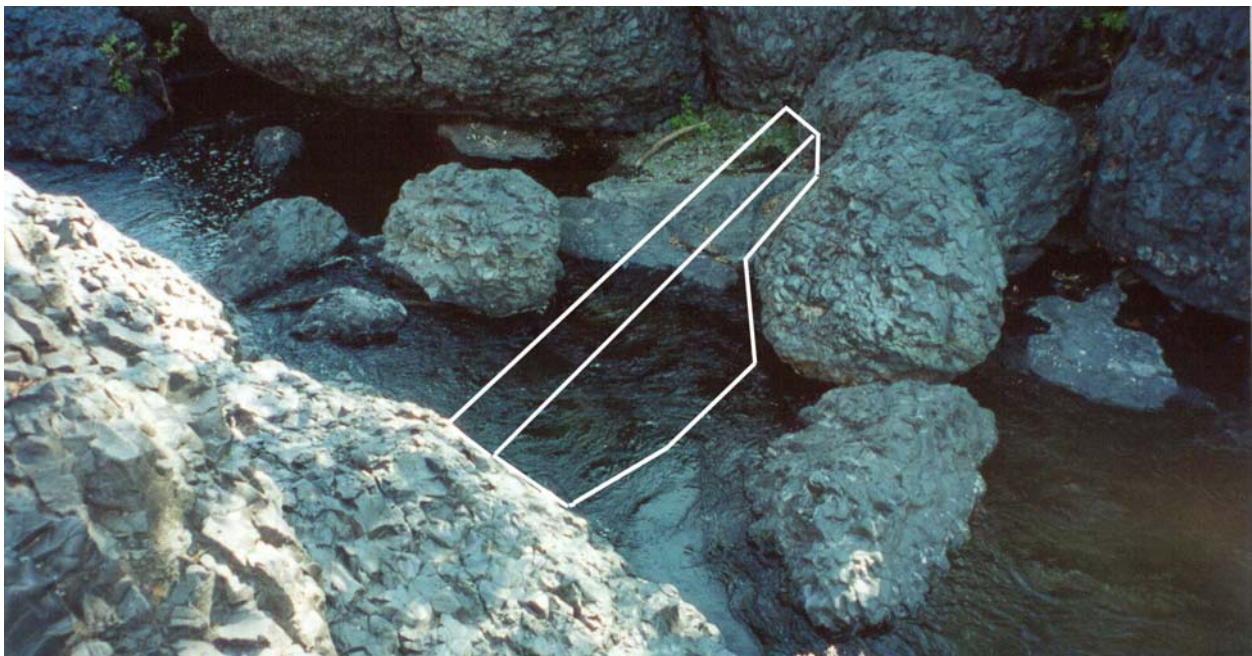


Figure 22. Sketch of typical proposed gradient control structure downstream of constriction area.

PROPOSED WORK

One or two gradient control structures would be constructed within the creek downstream of the existing constriction areas. Each structure would span the entire width of the channel at their respective locations and raise the water surface in a gradual step or steps depending on how many structures would be placed. The gradient control structures could be constructed with rocks, logs, steel, or concrete. Each gradient control structure would be keyed into the bottom of the creek to ensure stability and a good seal. The structure would be submerged during most, if not all flow conditions. The use of rocks or logs would make accomplishing the intended designed water surfaces more difficult and less permanent than using concrete or steel. A concern with rocks, logs, or a steel plate would be the difficulty of creating a seal along the cross section. The use of a concrete structure would make construction easier and ensure that a good seal across the entire cross section is achieved. For aesthetics,

native rock could be imbedded in the exterior of the new concrete structure to present a more natural look, even though the structure would be designed so that it would be submerged most of the time by water.

In addition to the placement of gradient control structures, some excavation would be done in the upper constriction area. The extent of the excavation would be minor compared to the work involved in Alternative 2 and could be done with a jackhammer or a rock hammer. Figure 23 shows an estimate of the excavation.



Figure 23. Estimate of the minor excavation at the upper constriction area.

Over time, the creek will deposit sediment and bedload behind the structure and begin the process of returning the creek site to a similar slope to the one that now exists upstream and downstream of the construction site. This process could be allowed to occur naturally or initiated by introducing native material after construction of the gradient control structure(s).

Maintenance

This alternative would require minimal maintenance after construction. The structures and the materials that would be deposited behind them over time should be monitored to ensure that conditions for unimpeded fish passage remain. The creek bed above the enlarged constriction area should be monitored occasionally for stability.

Table 18. Bear Hole Alternative 3 preliminary cost estimate.

**Big Chico Creek - Bear Hole Fish Passage Project
Preliminary Cost Estimate for Design and Construction
Alternative 3**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
<u>MISCELLANEOUS</u>					
1	Mobilization/Demobilization	1	LS	\$ 4,000	\$ 4,000
2	Site Work, Access, & Mitigation	1	LS	\$ 3,000	\$ 3,000
3	Dewatering	1	LS	\$ 20,000	\$ 20,000
					\$ 27,000
<u>Constriction</u>					
4	Excavation - Rock	1	LS	\$ 1,000	\$ 1,000
5	Concrete - Gradient Control Structures	20	CY	\$ 1,000	\$ 20,000
					\$ 21,000
6	Construction Cost				\$ 48,000
7	Contingency @ 25%				\$ 12,000
8	Construction Cost Subtotal				\$ 60,000
9	Engineering				\$ 26,000
10	Environmental				\$ 13,000
11	Construction Inspection				\$ 13,000
12	Contract Administration				\$ 26,000
13	Total				\$ 138,000

ALTERNATIVE 4 - Add Gradient Control Structure(s)

This alternative would involve introducing a new gradient control structure(s) downstream that would raise the water surface to make fish passage easier at the existing constriction area. The task involved would be:

- Add a gradient control structure(s) downstream of the constriction area to provide a gradual step(s) past the constriction area.

PROPOSED WORK

The proposed work would introduce one or two gradient control structures as discussed in Alternative 3. No excavation of the upper constriction area would be done. Raising the water surface downstream of the upper constriction area would improve fish passage.

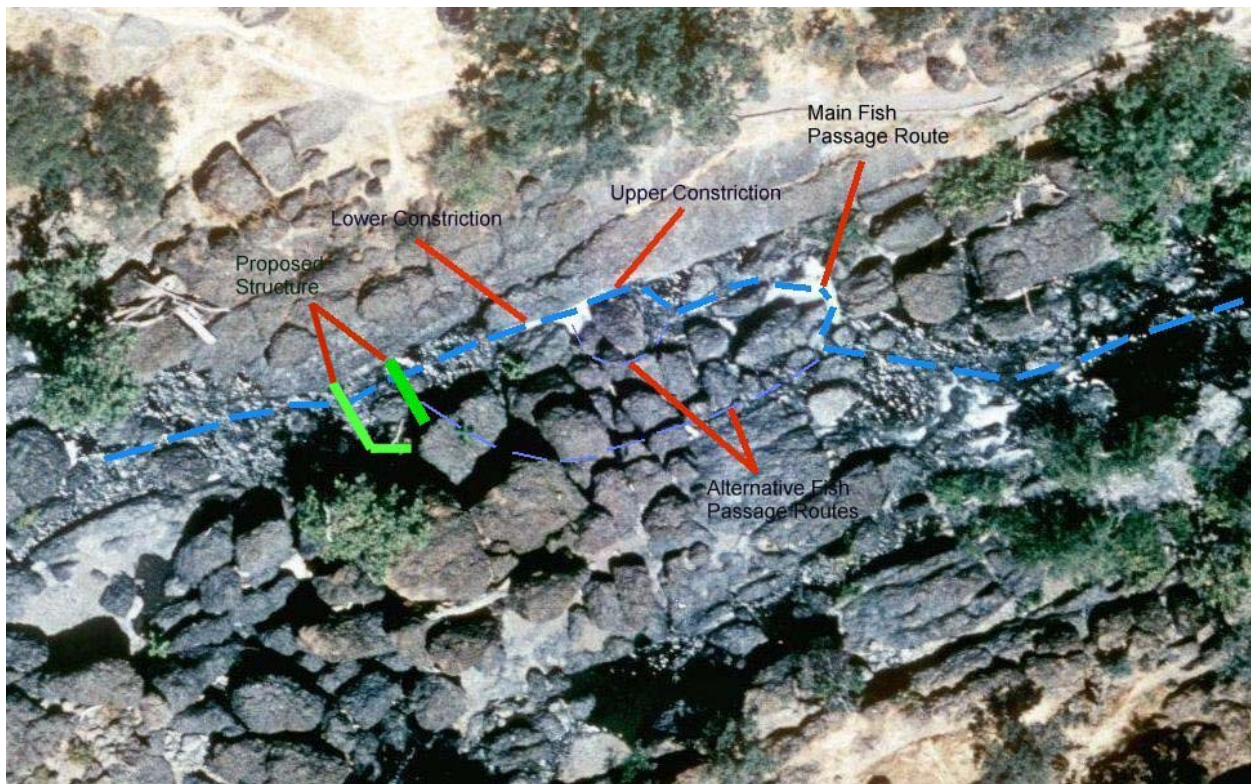


Figure 24. Aerial photo of Bear Hole with proposed gradient control structures.

Maintenance

This alternative would require minimal maintenance after construction. The structures and materials that are deposited behind them over time should be monitored to ensure that conditions for unimpeded fish passage remain.

Table 19. Bear Hole Alternative 4 preliminary cost estimate.

**Big Chico Creek - Bear Hole Fish Passage Project
Preliminary Cost Estimate for Design and Construction
Alternative 4**

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
<u>MISCELLANEOUS</u>					
1	Mobilization/Demobilization	1	LS	\$ 4,000	\$ 4,000
2	Site Work, Access, & Mitigation	1	LS	\$ 2,500	\$ 3,000
3	Dewatering	1	LS	\$ 20,000	\$ 20,000
					\$ 27,000
<u>Constriction</u>					
4	Concrete - Gradient Control Structures	20	CY	\$ 1,000	\$ 20,000
					\$ 20,000
5	Construction Cost				\$ 47,000
6	Contingency @ 25%				\$ 12,000
7	Construction Cost Subtotal				\$ 59,000
8	Engineering				\$ 26,000
9	Environmental				\$ 13,000
10	Construction Inspection				\$ 13,000
11	Contract Administration				\$ 26,000
12	Total				\$ 137,000

Bear Hole Design and Construction Summary

Site Conditions and Assumptions

The preliminary layout and design drawings contained in this report will be refined during the final design process. Additional surveys, hydraulic analyses, and geologic explorations may be necessary because of changes in the site conditions since this investigation was conducted.

Codes and Standards

Final designs will be governed by the following criteria:

- Final structural designs will comply with the latest Uniform Building Code requirements.
- Final concrete designs will comply with the latest American Concrete Institute Building Code Requirements for Reinforced Concrete Design.
- All current applicable CalOSHA safety standards will be met.
- All environmental permit conditions will be met.

Final Design Instructions

Final designs will adhere to the following directives:

- A complete operations and maintenance manual will be completed prior to project completion.
- The elevations shown for Bear Hole are based on NAVD 88 (feet) Datum. Descriptions and elevations of control points can be obtained from ND.
- Actual concrete thickness and reinforcement requirements will be determined by the final design engineer.

Construction Summary

At the Bear Hole site, no improvements of existing access roads leading to the north side of the creek are proposed. Personnel access to the project site is currently provided by foot trails that begin in the parking area adjacent to the project site. No access is available from the south side of the creek.

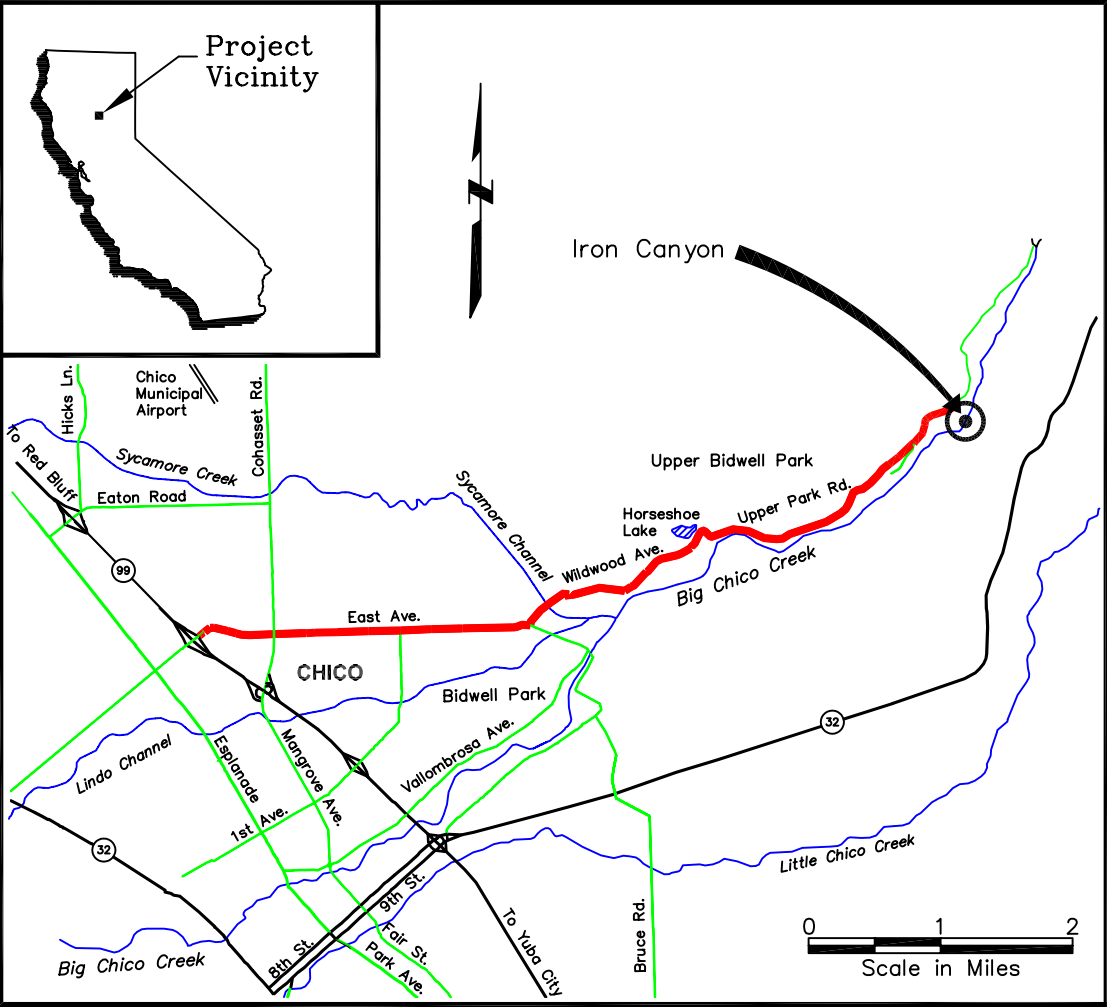
Staging areas would exist on the north side of the creek. The limits of the staging areas and access routes should be marked and managed to prevent vehicular or personnel access outside the designated construction zone. A small storage area is needed on the north side of the creek to store a small amount of equipment and fuels.

A temporary cofferdam upstream of the work site could direct a majority of the flow into a side channel that would bypass the project site. Pumps would also be needed to remove any excess water at the site. Any gravel and rock that is excavated could remain on site where it will not interfere with fish passage or the natural flow of the creek.

PRELIMINARY ENGINEERING
DRAWINGS FOR

IRON CANYON
FISH PASSAGE PROJECT
ON BIG CHICO CREEK

BUTTE COUNTY, CALIFORNIA



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- Sheet 2 of 16 – Access Map
- Sheet 3 of 16 – General Plan
- Sheet 4 of 16 – Site Plan – Alternatives 2 & 3
- Sheet 5 of 16 – Site Plan – Alternative 4
- Sheet 6 of 16 – Fishway Profile – Alternative 2
- Sheet 7 of 16 – Fishway Profile – Alternative 3
- Sheet 8 of 16 – Fishway Profile – Alternative 4
- Sheet 9 of 16 – Fishway Exit Profile
- Sheet 10 of 16 – Typical Fish Ladder Sections – Alternatives 3 & 4

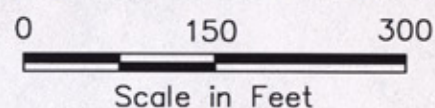
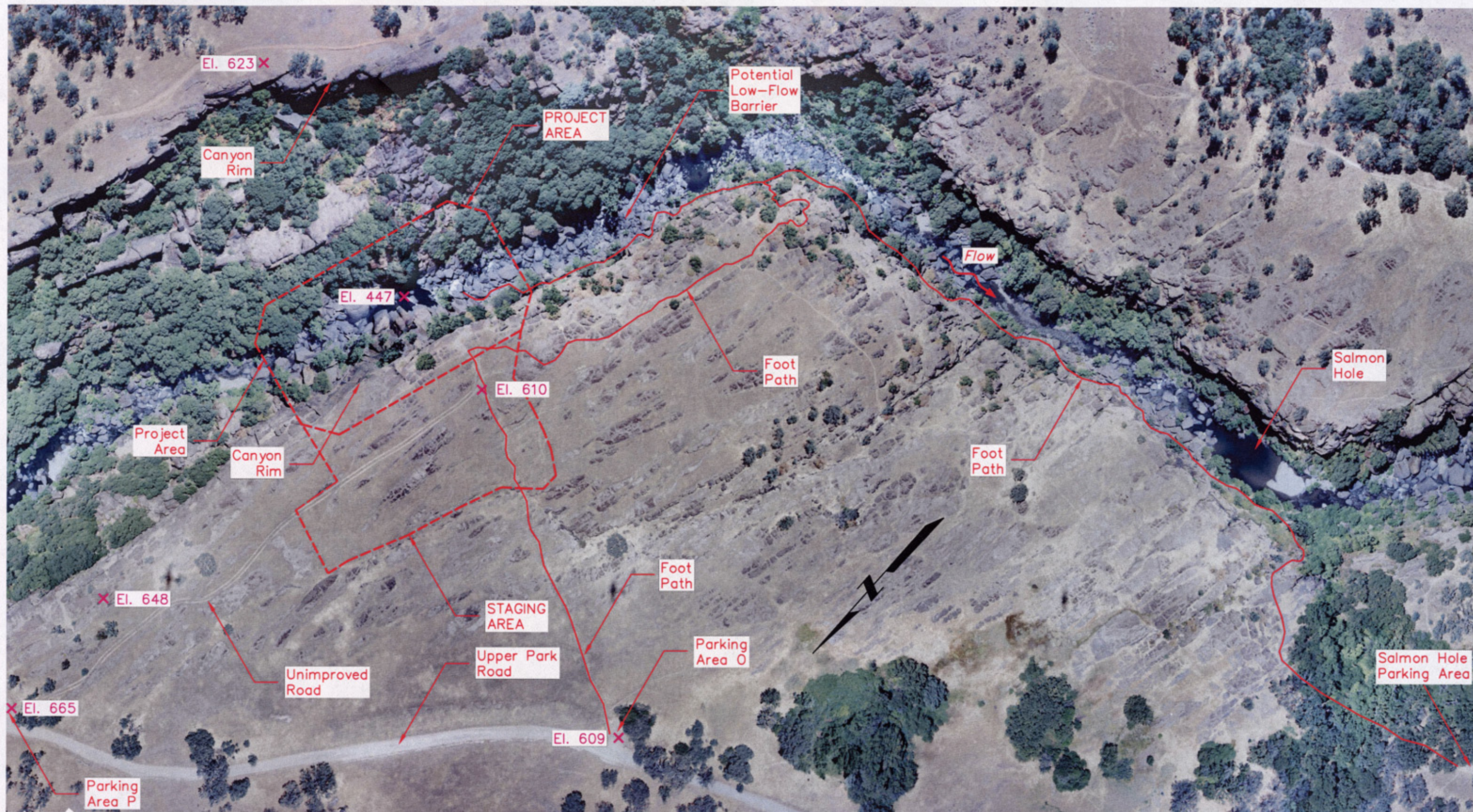
Note: All Proposed Work Denoted in Upper Case Text

PRELIMINARY
SUBJECT TO REVISION

IRON CANYON
Big Chico Creek in Chico, California

Title Sheet and Area Map

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	DRAWING : Iron-Title-SDK
Revision Date: October 3, 2001	Sheet 1 of 16



Notes:
 1) Vertical Datum NAVD 88, Feet.
 2) Photograph Date: 06/30/00.
 3) Survey Performed 07/00.

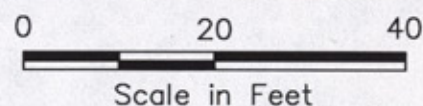
Legend
 X Spot Elevation

Iron Canyon Fish Passage Project
 Big Chico Creek in Chico, CA

Access Map

STATE OF CALIFORNIA
 THE RESOURCES AGENCY
 DEPARTMENT OF WATER RESOURCES
 NORTHERN DISTRICT
 Revision Date: October 3, 2001

DRAWING :
 Project Access
 Part-1.1
 Sheet 2 of 16



Notes:

- 1) Vertical Datum NAVD 88, Feet.
- 2) Photograph Date: 06/30/00.
- 3) Survey Performed 07/00.

- 4) Pool 10 is in tunnel section.
- 5) Pools 14-16 are in tunnel section.

Legend

- X Spot Elevation
- Concrete Walls
- Rock Walls

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

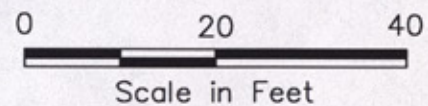
General Plan

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT

Revision Date: October 3, 2001

DRAWING :
Iron_CanyonSP
-SDK-1.1

Sheet 3 of 16



Notes:

- 1) Vertical Datum NAVD 88, Feet.
- 2) Photograph Date: 06/30/00.
- 3) Survey Performed 07/00.

- 4) Pool 10 is in tunnel section.
- 5) Pools 14-16 are in tunnel section.

Legend

- X Spot Elevation
- Concrete Walls
- Rock Walls

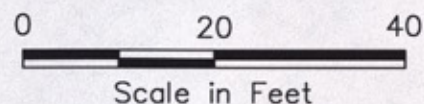
- Rock Walls
- Fishway Flowline
- New Weirs

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

Site Plan – Alternatives 2 & 3

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
Revision Date: October 3, 2001

DRAWING :
Iron_CanyonSP
-SDK-1.1
Sheet 4 of 16



Notes:

- 1) Vertical Datum NAVD 88, Feet.
- 2) Photograph Date: 06/30/00.
- 3) Survey Performed 07/00.

- 4) Pool 10 is in tunnel section.
- 5) Pools 14-16 are in tunnel section.

Legend

- X Spot Elevation
- Concrete Walls
- Rock Walls

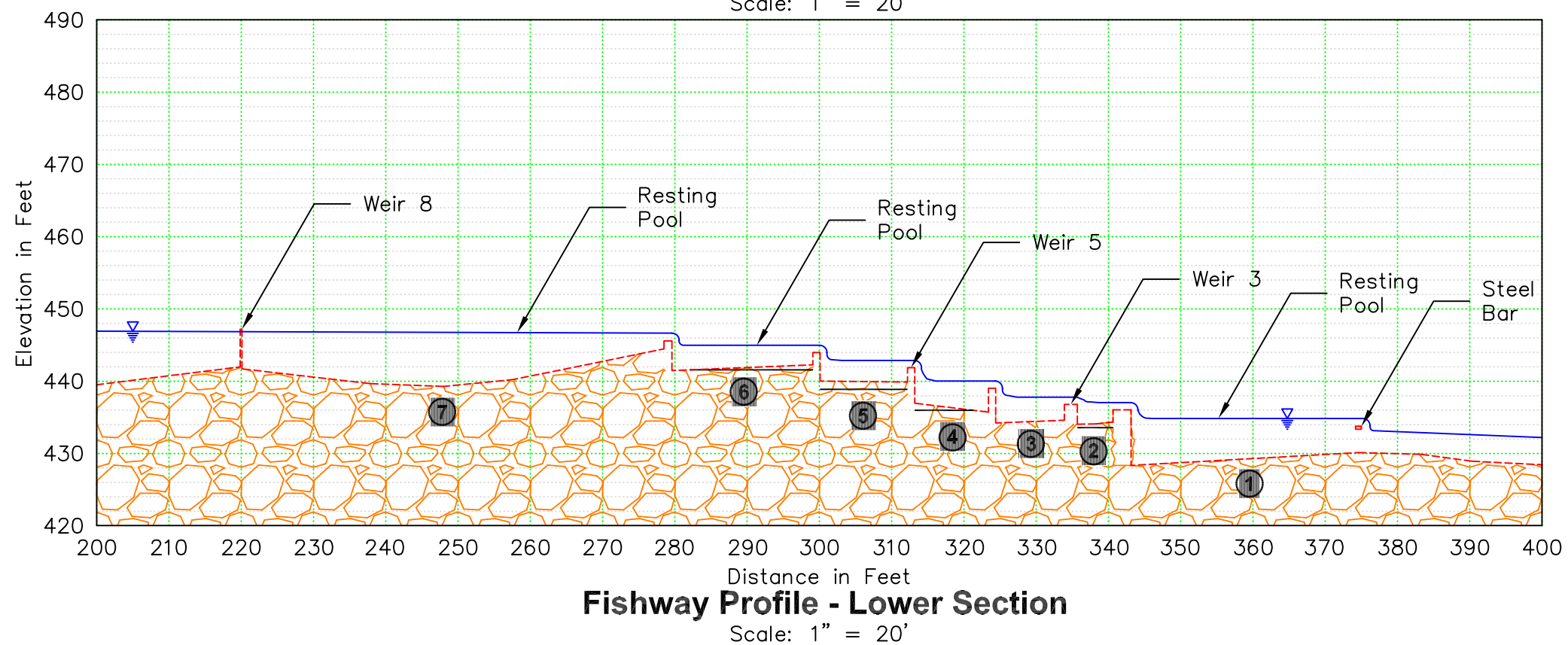
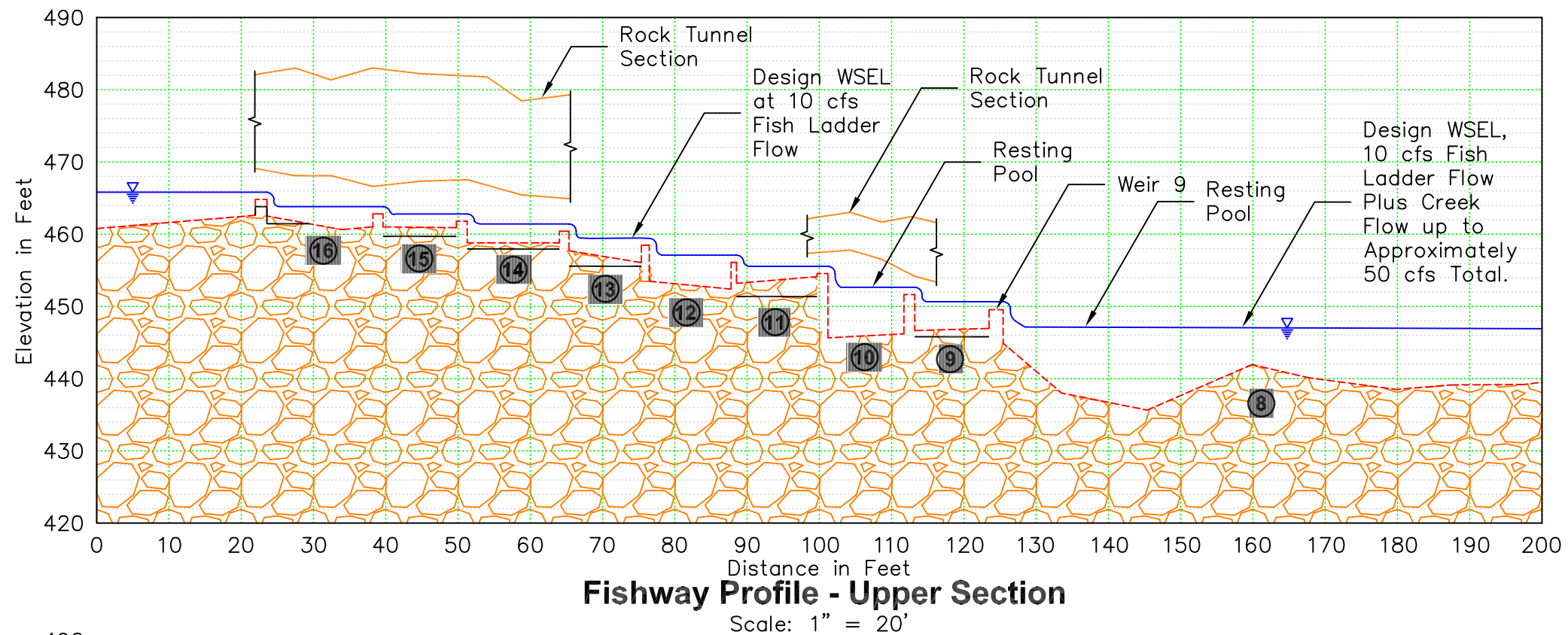
- Rock Walls
- Fishway Flowline
- New Weirs

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

Site Plan - Alternative 4

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
Revision Date: October 3, 2001

DRAWING :
Iron_CanyonSP
-SDK-1.1
Sheet 5 of 16



Notes:

- | | |
|----------------------------------|---------------------------------------|
| 1) Vertical Datum NAVD 88, Feet. | 4) Pool 10 is in tunnel section. |
| 2) Survey Performed 07/00. | 5) Pools 14–16 are in tunnel section. |

Legend

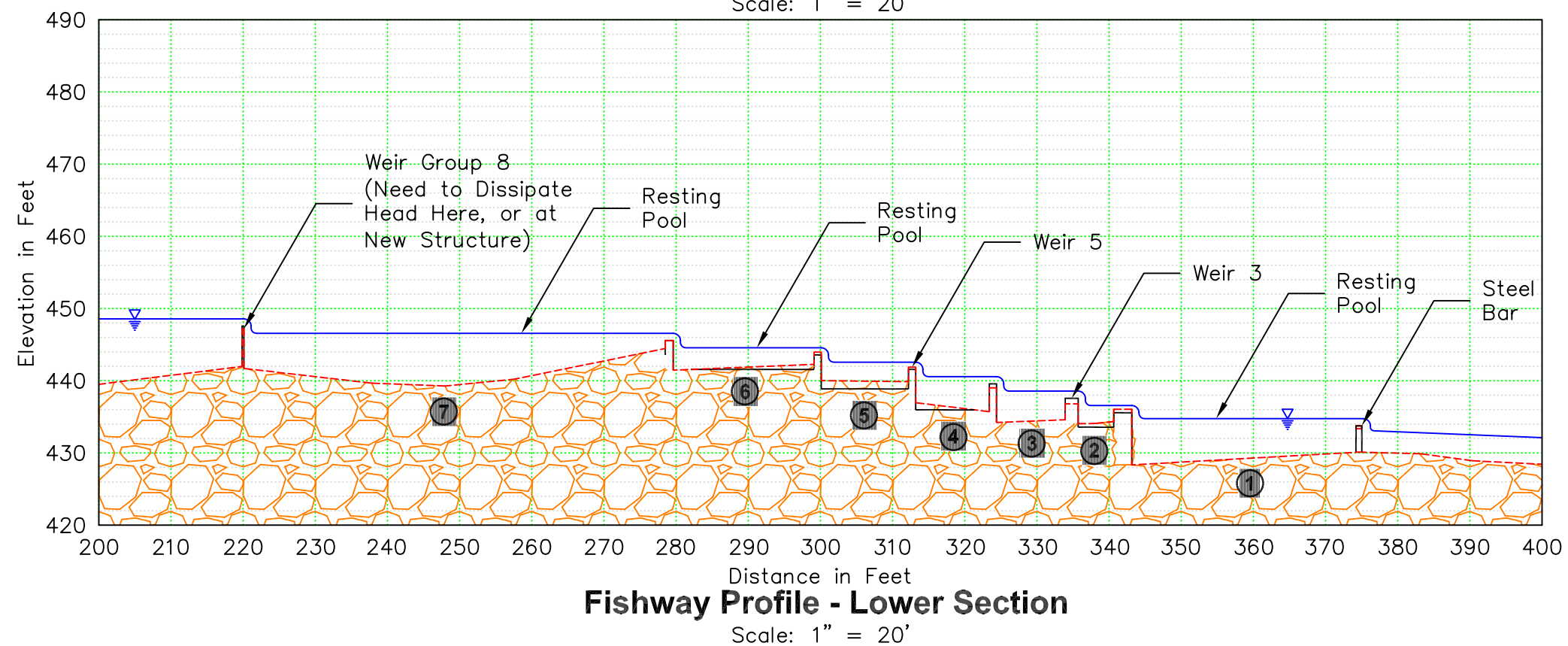
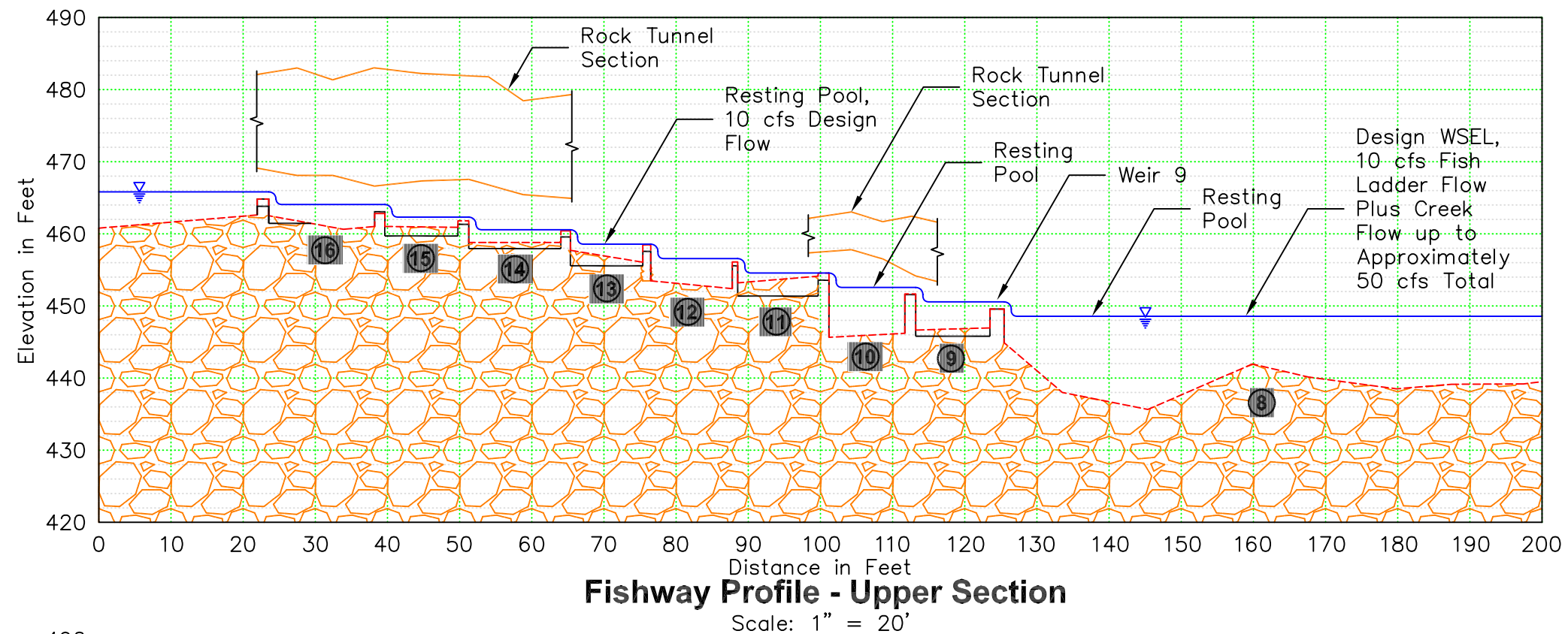
- | | | | |
|-----------------|-----------------------------|-------------|----------------------|
| # | Pool Number | — | Proposed Pool Invert |
| Orange hatched | Existing Ground | Orange line | Tunnel Boulders |
| Red dashed line | Existing Weirs and Flowline | Blue line | Design Water Surface |

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

Fishway Profile
Alternative 2

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
Revision Date: October 3, 2001

DRAWING :
Iron_Profile_
and_Sections
Sheet 6 of 16



Notes:

- 1) Vertical datum NAVD 88
- 2) Survey performed 07/00
- 3) Pool 10 is in tunnel section

- 5) Pools 14–16 are in tunnel section

Legend

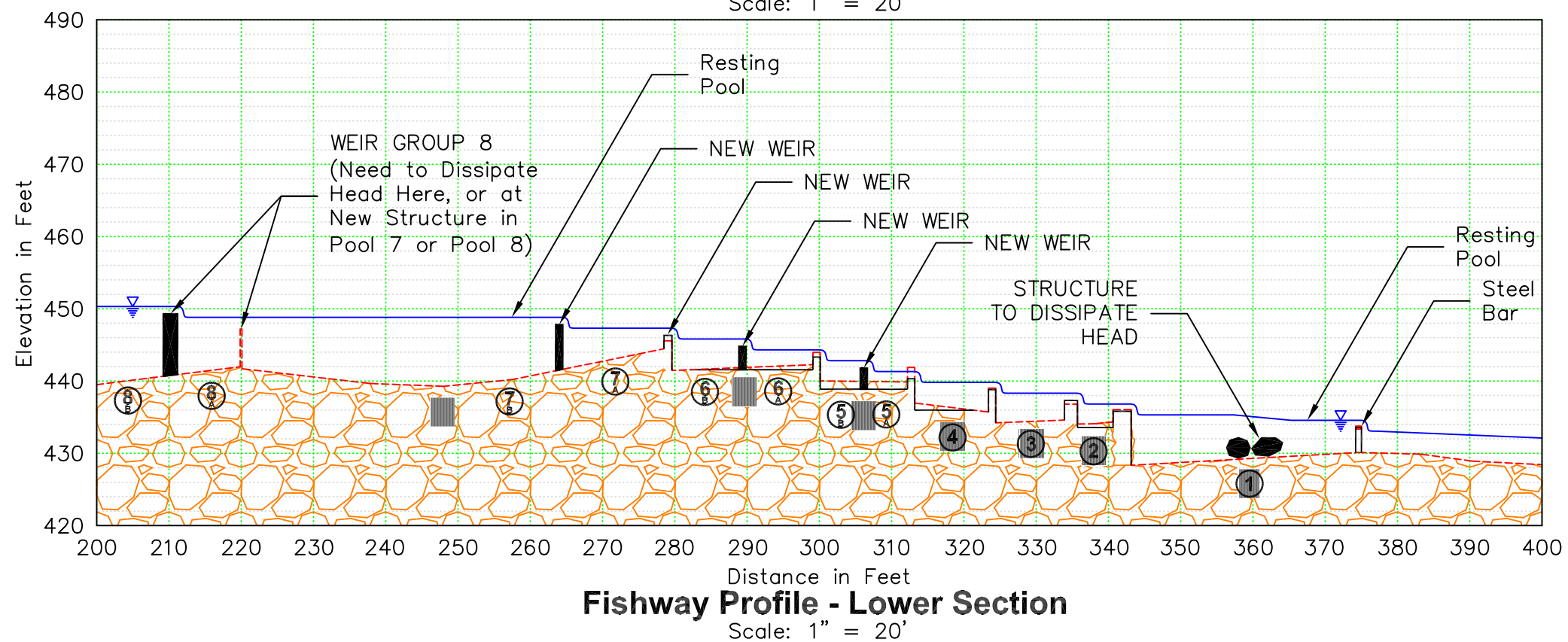
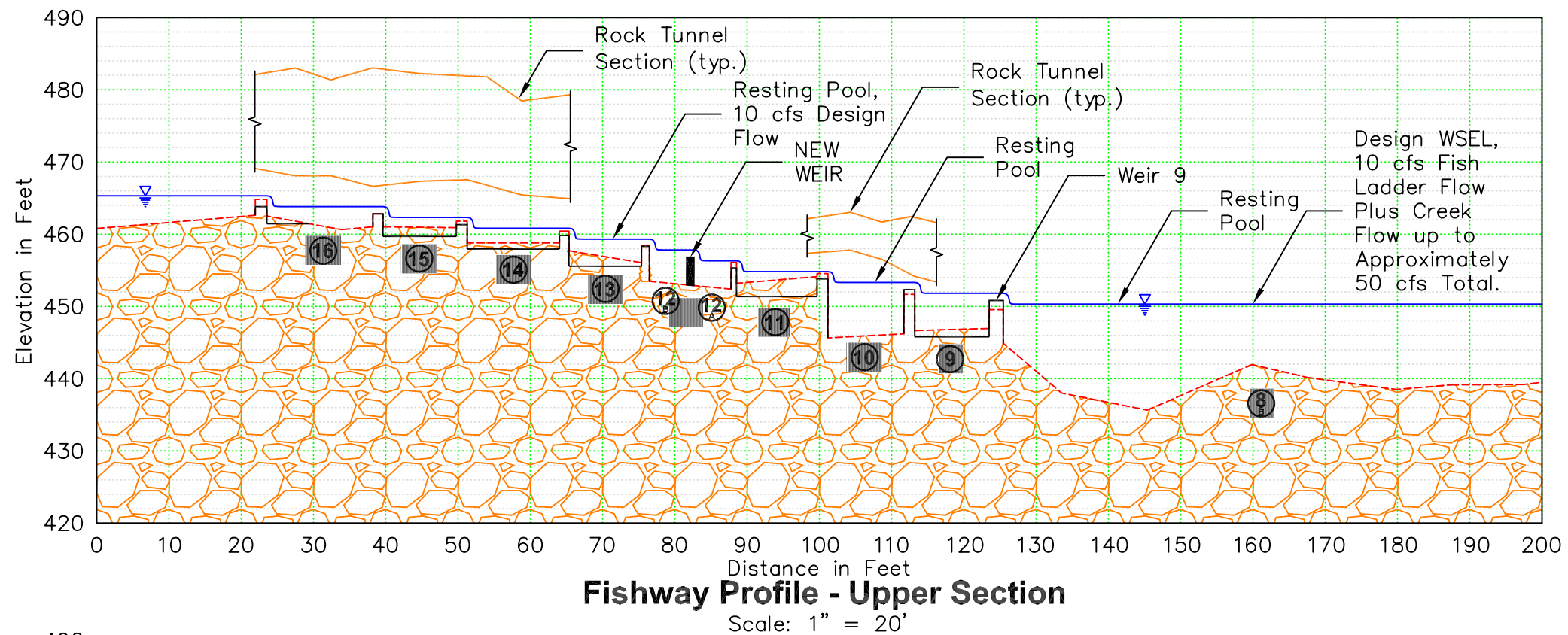
- | | | | |
|---|-----------------------------|---|-----------------------------|
| # | Pool Number | — | Proposed Weirs and Flowline |
| | Existing Ground | | Tunnel Boulders |
| | Existing Weirs and Flowline | | Design Water Surface |

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

Fishway Profile
Alternative 3

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
Revision Date: October 3, 2001

DRAWING :
Iron_Profile_
and_Sections
Sheet 7 of 16



Notes:

- 1) Vertical Datum NAVD 88, Feet.
- 2) Survey performed 07/00.
- 3) Pool 10 is in tunnel section.
- 5) Pools 14–16 are in tunnel section.

Legend

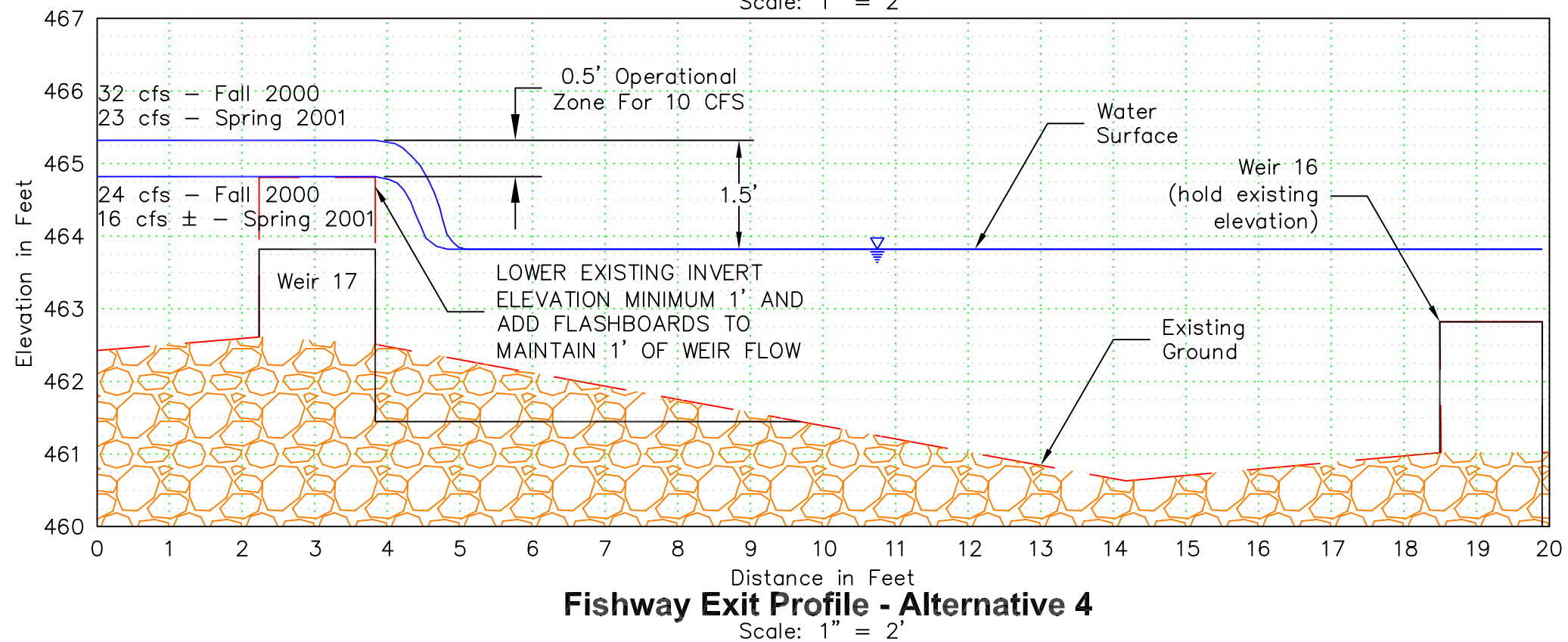
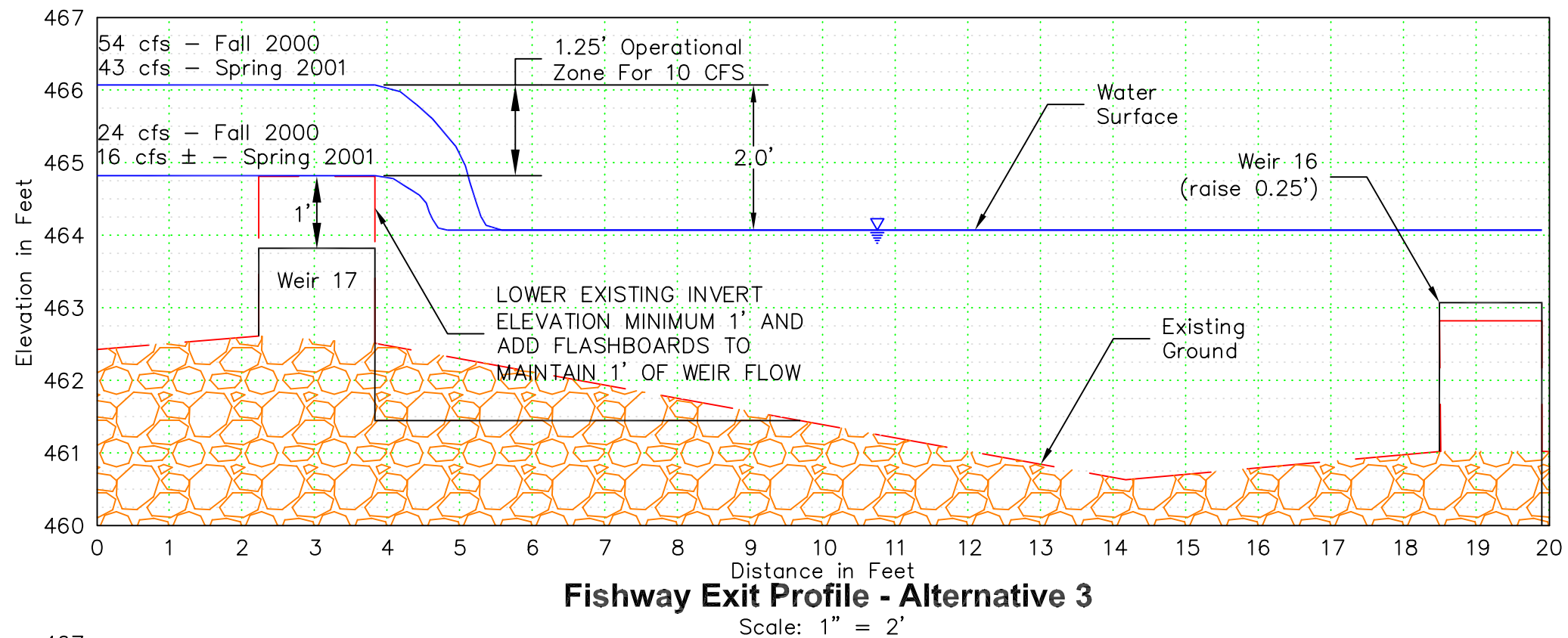
- | | | | |
|-----------------|-----------------------------|-------------|-----------------------------|
| # | Pool Number | — | Proposed Weirs and Flowline |
| Orange hatched | Existing Ground | Orange line | Tunnel Boulders |
| Red dashed line | Existing Weirs and Flowline | Blue line | Design Water Surface |

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

Fishway Profile
Alternative 4

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
Revision Date: October 3, 2001

DRAWING :
Iron_Profile_
and_Sections
Sheet 8 of 16



Notes:

- 1) Vertical Datum NAVD 88, Feet.
- 2) Survey performed 07/00.

Legend

- Existing Ground
- Existing Weirs and Flowline
- Design Water Surface

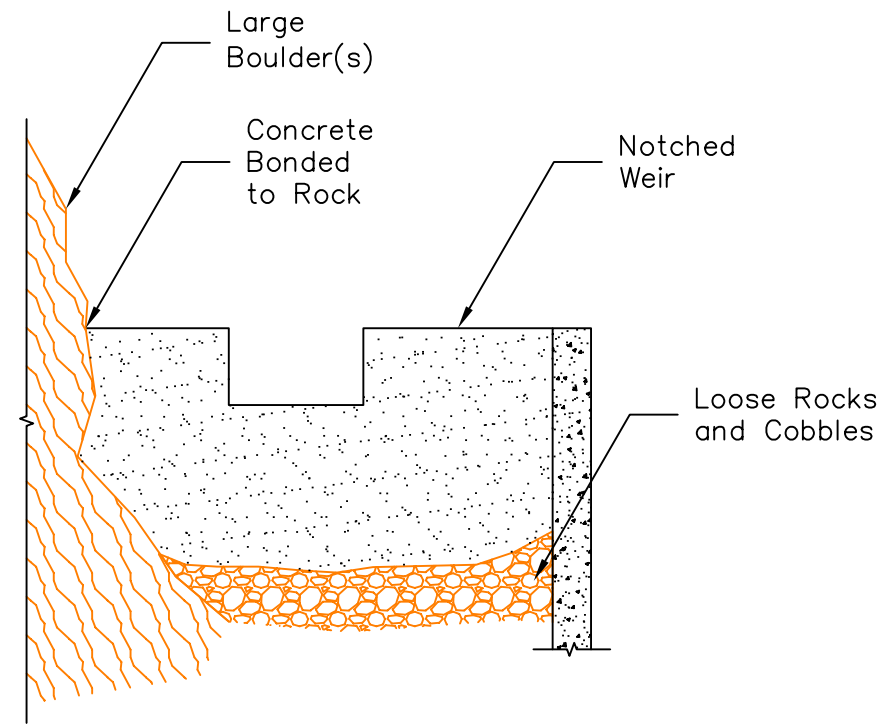
Proposed Weirs and Flowline

Iron Canyon Fish Passage Project
Big Chico Creek in Chico, CA

Fishway Exit Profile
Alternatives 3 and 4

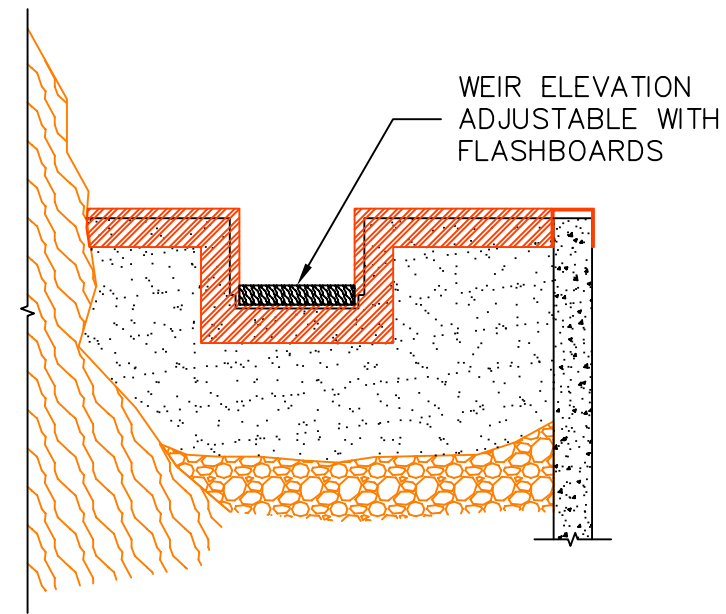
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
Revision Date: October 3, 2001

DRAWING :
Iron_Profile_
and_Sections
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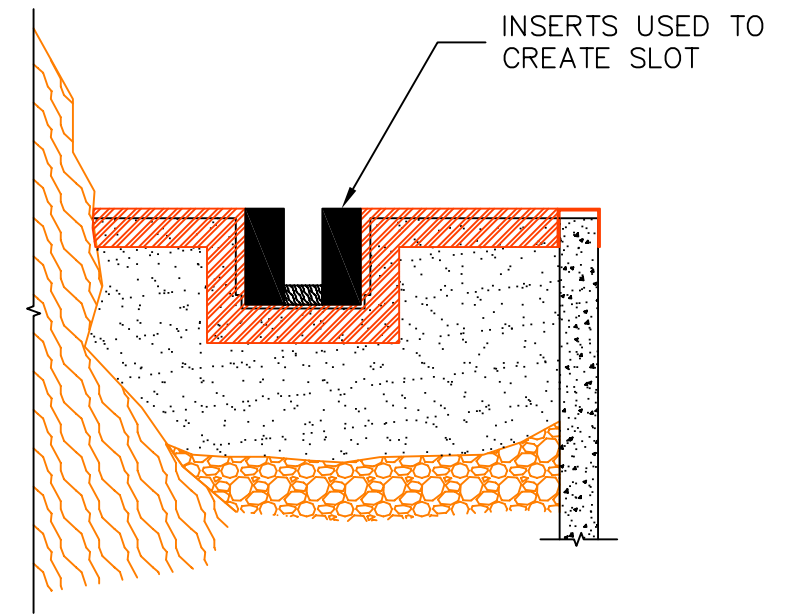
Typical Lower Fishway Section

Scale: 1" = 5'



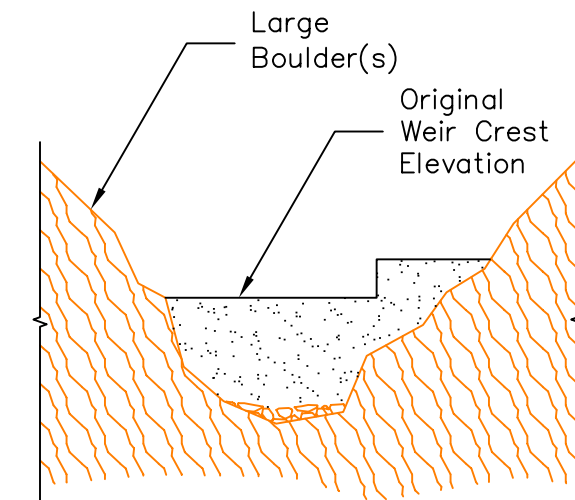
Variable Weirs - Lower Section, Weir Configuration

Scale: 1" = 5'



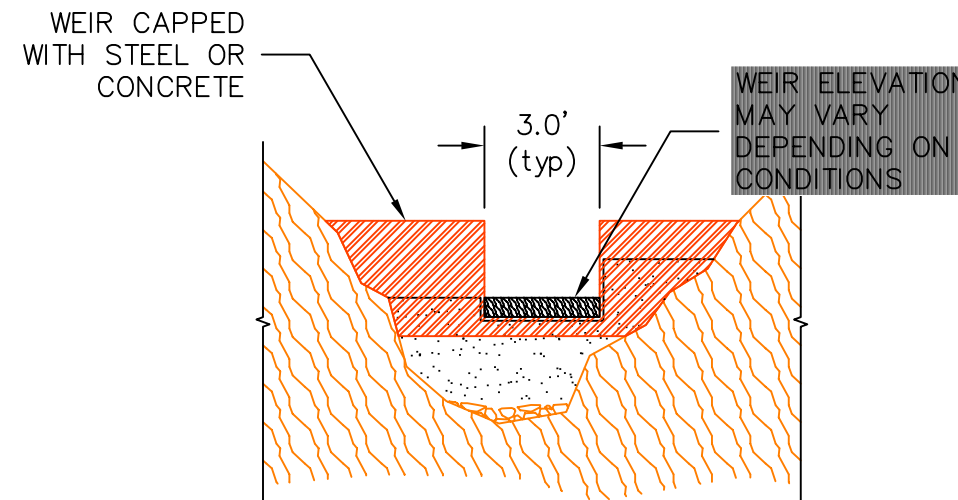
Variable Weirs - Lower Section, Slot Configuration

Scale: 1" = 5'



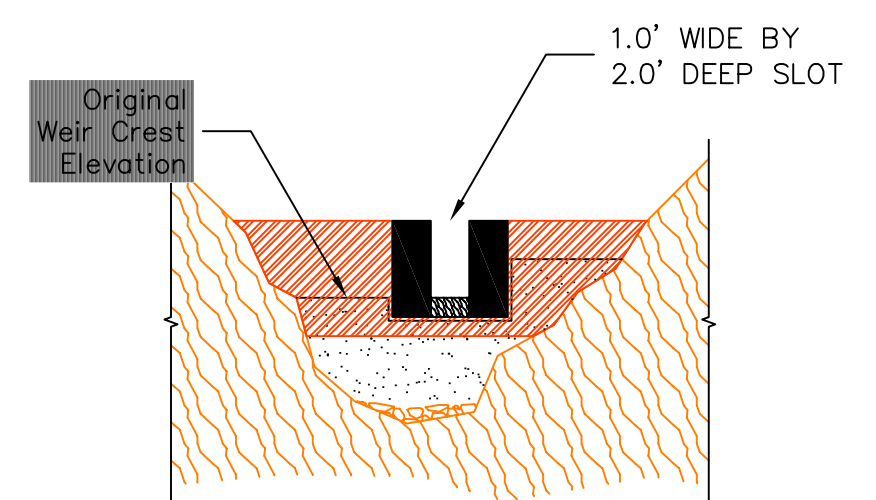
Typical Upper Fishway Section

Scale: 1" = 5'



Variable Weirs - Upper Section, Weir Configuration

Scale: 1" = 5'



Variable Weirs - Upper Section, Slot Configuration

Scale: 1" = 5'

Notes:

- 1) This sheet depicts typical weirs.
- 2) Weirs 8 and 17 are special cases and are not shown above.

Legend

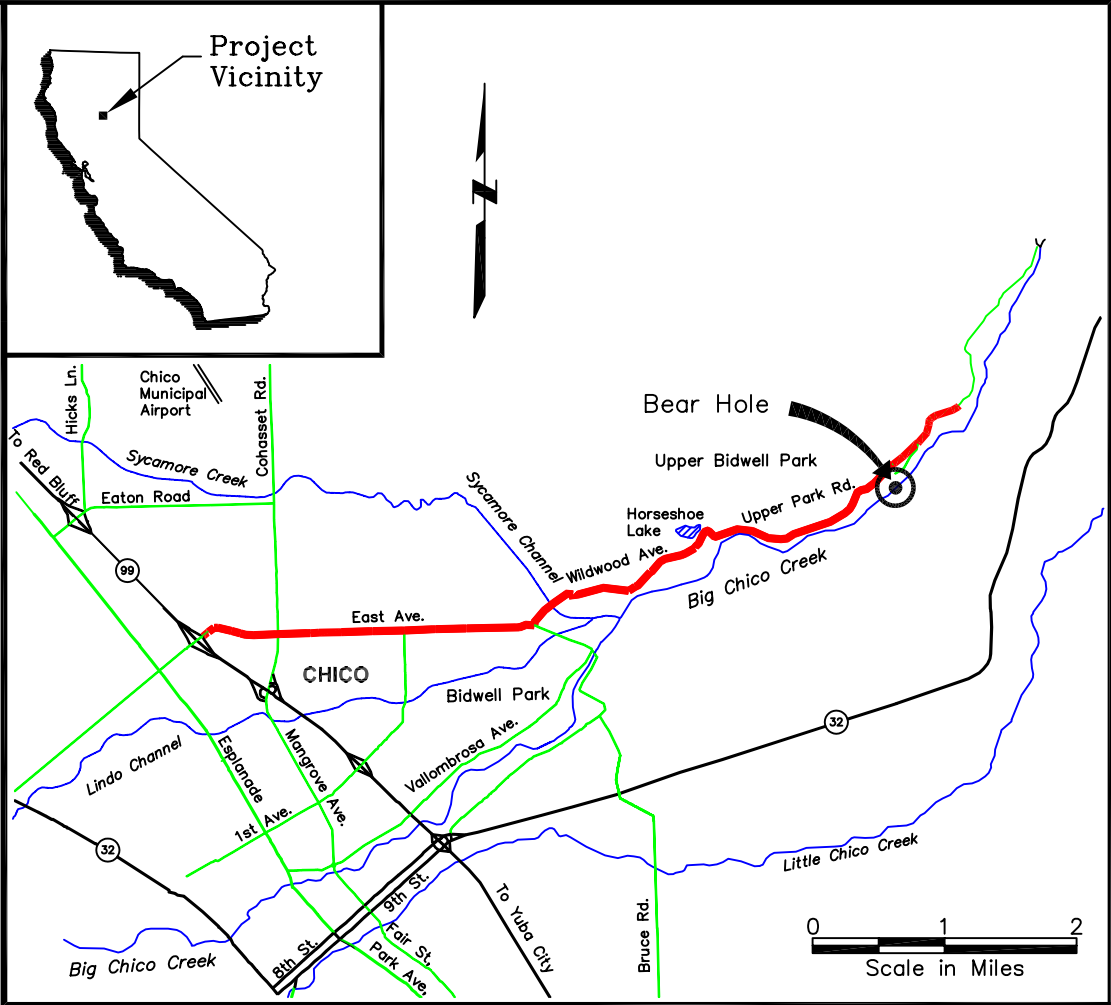
- Cobbles or Gravel
- Concrete Walls

- Large Rocks or Boulders
- Modified Weirs

PRELIMINARY ENGINEERING
DRAWINGS FOR

**BEAR HOLE
FISH PASSAGE PROJECT
ON BIG CHICO CREEK**

BUTTE COUNTY, CALIFORNIA



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- Sheet 12 of 16 – General Plan
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- Sheet 14 of 16 – Existing Flow Profiles and Constriction Modification profile
- Sheet 15 of 16 – Gradient Control Structures Estimated Flow Profiles
- Sheet 16 of 16 – Gradient Control Structures Sections

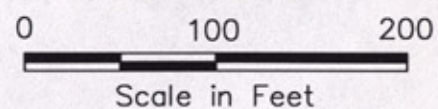
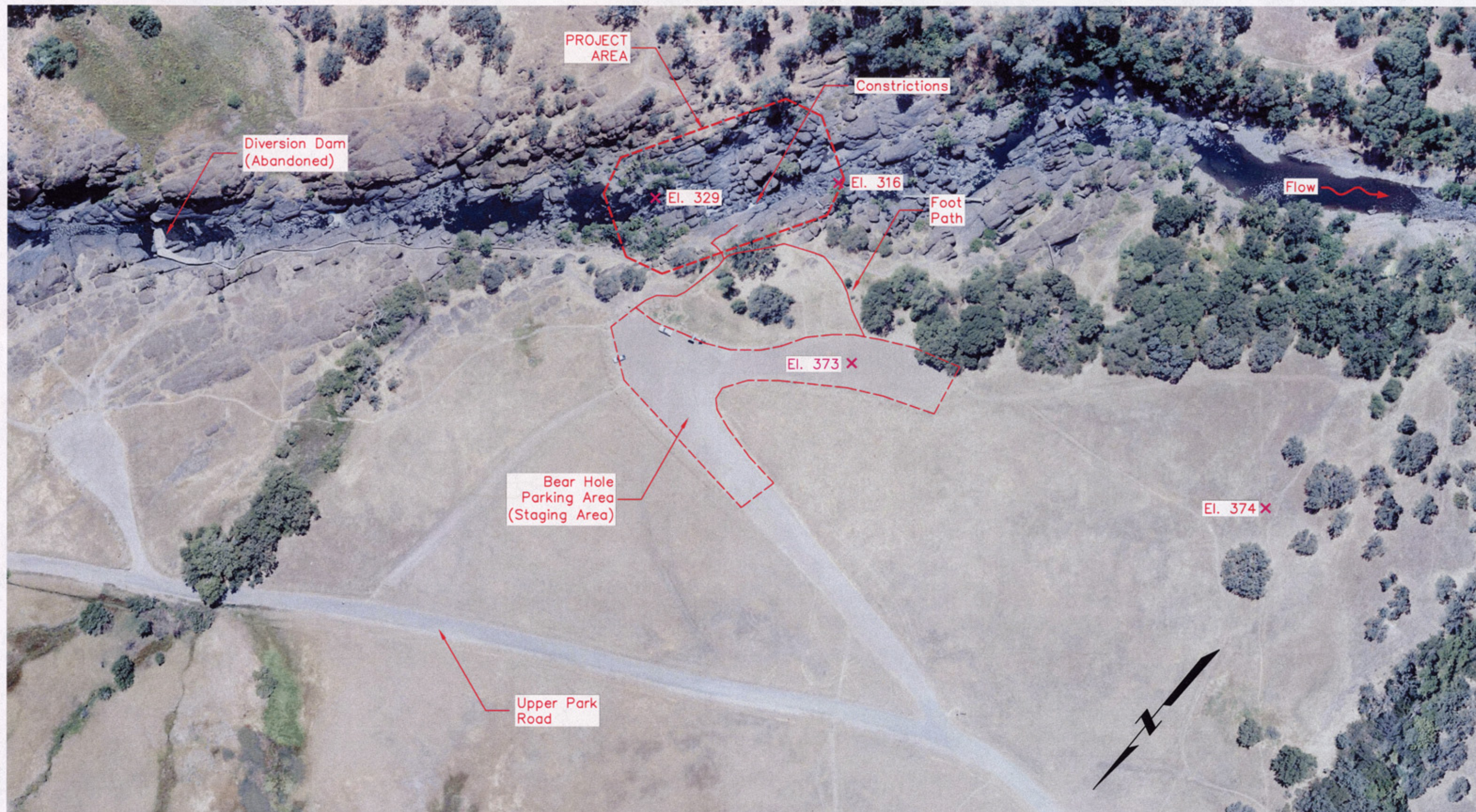
Note: All Proposed Work Denoted in Upper Case Text

**PRELIMINARY
SUBJECT TO REVISION**

BEAR HOLE
Big Chico Creek in Chico, California

Title Sheet and Area Map

STATE OF CALIFORNIA THE RESOURCES AGENCY DEPARTMENT OF WATER RESOURCES NORTHERN DISTRICT	DRAWING : Bear-Title-SDK
Revision Date: October 3, 2001	Sheet 11 of 16



- Notes**
- 1) Vertical Datum NAVD 88, Feet
 - 2) Photograph Date: 06/30/00
 - 3) Survey Performed 07/00

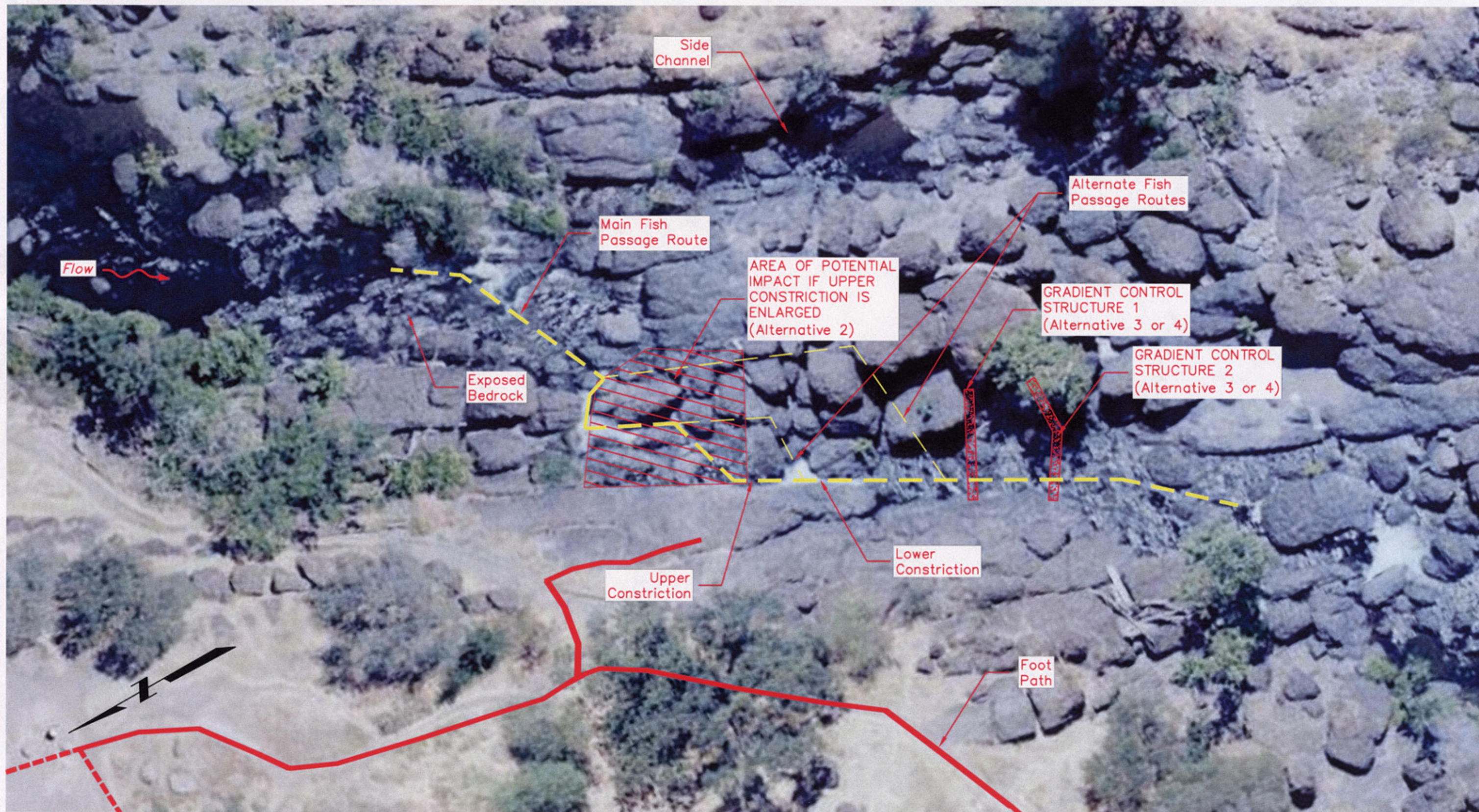
Legend
 X Spot Elevation

Bear Hole Fish Passage Project
 Big Chico Creek in Chico, CA

General Plan

STATE OF CALIFORNIA
 THE RESOURCES AGENCY
 DEPARTMENT OF WATER RESOURCES
 NORTHERN DISTRICT
 Revision Date: October 2, 2001

DRAWING :
 Project_Access.dwg
 Sheet 12 of 16



0 20 40
Scale in Feet

Notes

- 1) Vertical Datum NAVD 88
- 2) Photograph Date: 06/30/00
- 3) Survey Performed 07/00

Bear Hole Fish Passage Project
Big Chico Creek in Chico, CA

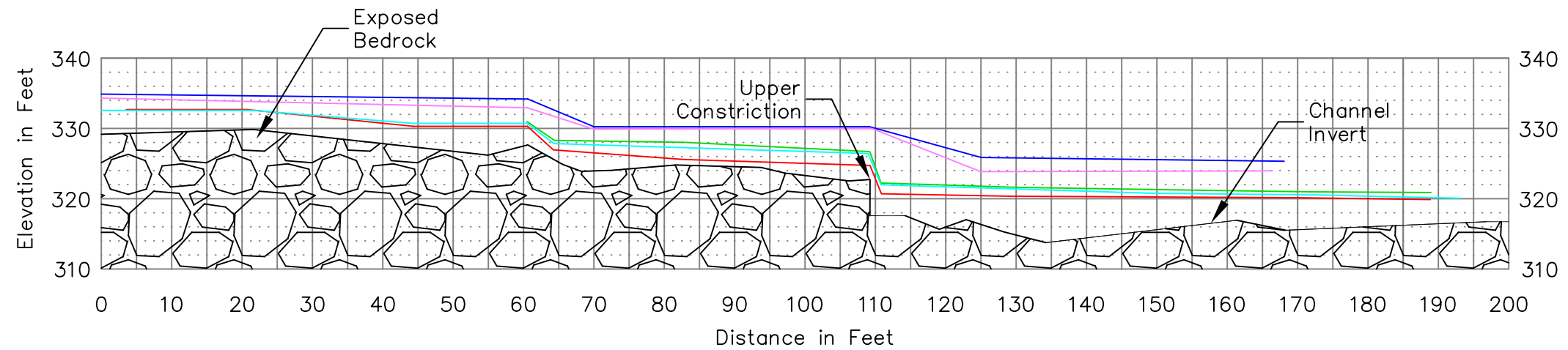
Site Plan – Alternatives 2, 3, & 4

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT

Revision Date: October 2, 2001

DRAWING :
Project_Access.dwg

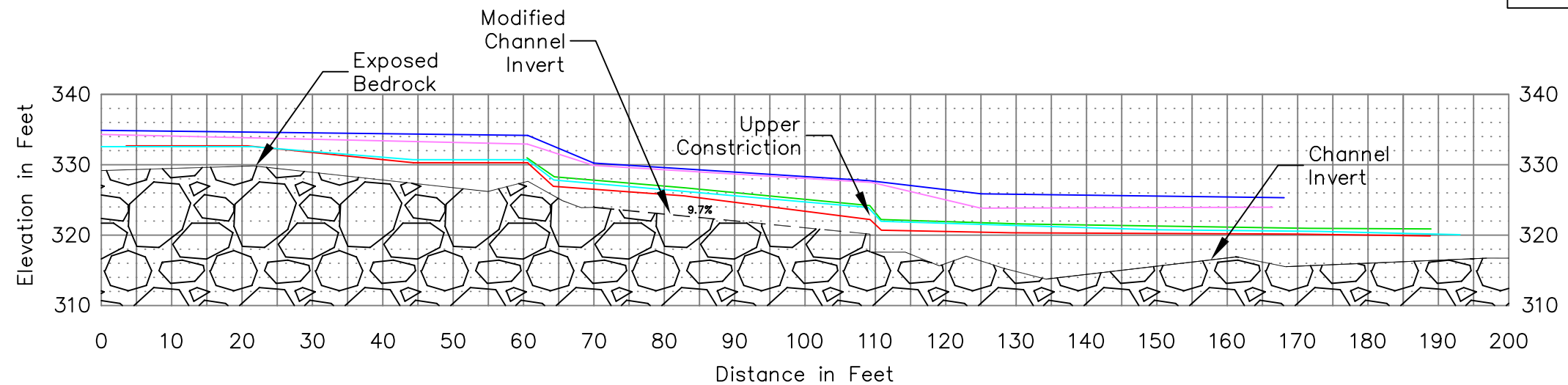
Sheet 13 of 16



Existing Flow Profiles

Scale: 1" = 20'

24 CFS	Surveyed directly
46 CFS	Delineated from photos
66 CFS	Delineated from photos
274 CFS	Delineated from photos
523 CFS	Delineated from photos

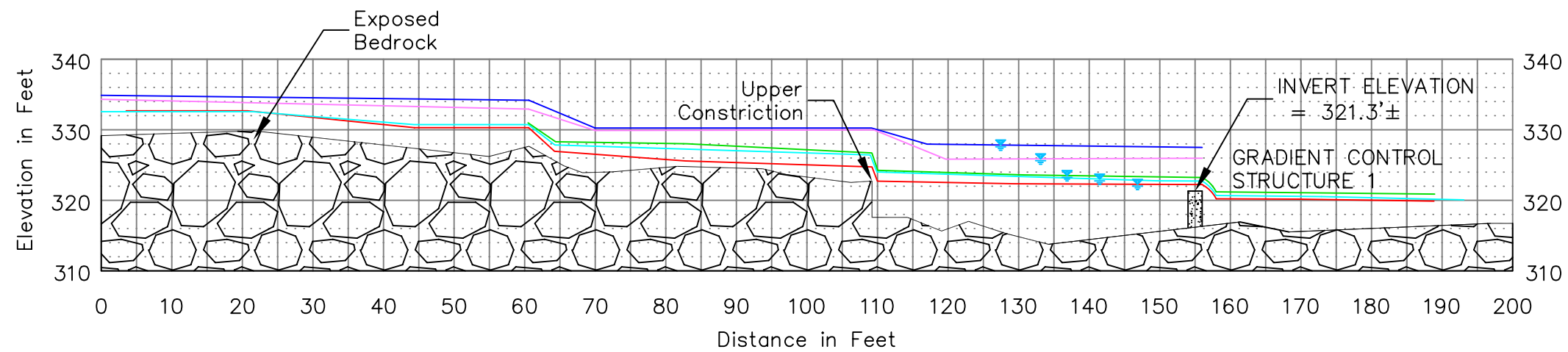


Estimated Flow Profiles After Enlarging Upper Constriction

Scale: 1" = 20'

Notes:

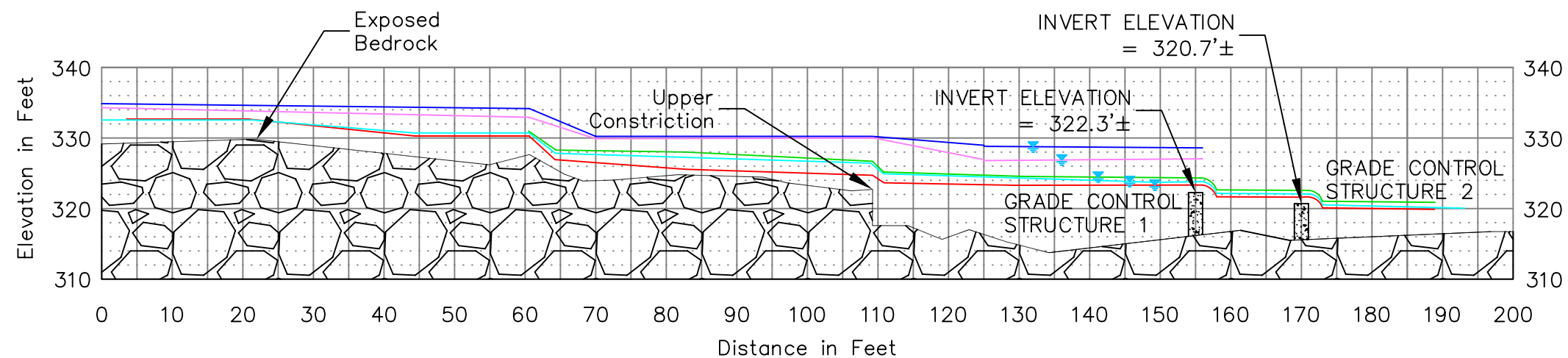
- 1) Vertical Datum is NAVD 88, Feet.
- 2) Survey performed in 2000.



Estimated Flow Profiles with 1 Gradient Control Structure

Scale: 1" = 20'

24 CFS	Surveyed directly
46 CFS	Delineated from photos
66 CFS	Delineated from photos
274 CFS	Delineated from photos
523 CFS	Delineated from photos

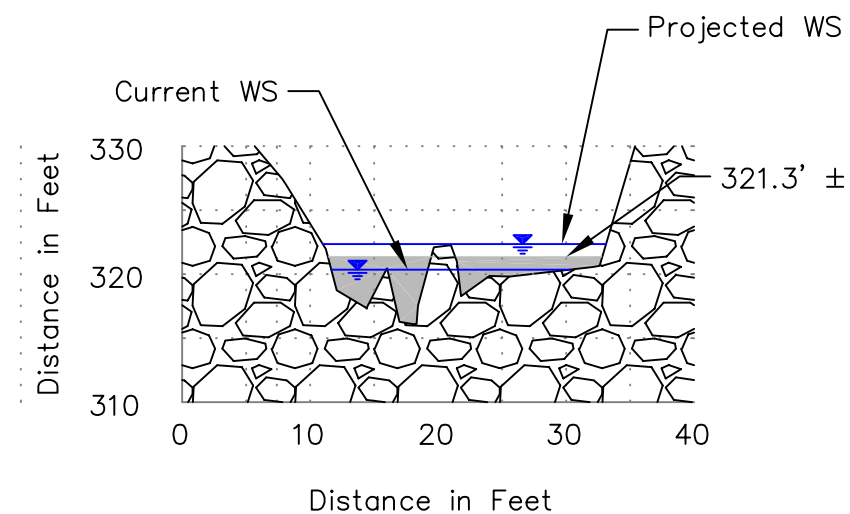


Estimated Flow Profiles with 2 Gradient Control Structures

Scale: 1" = 20'

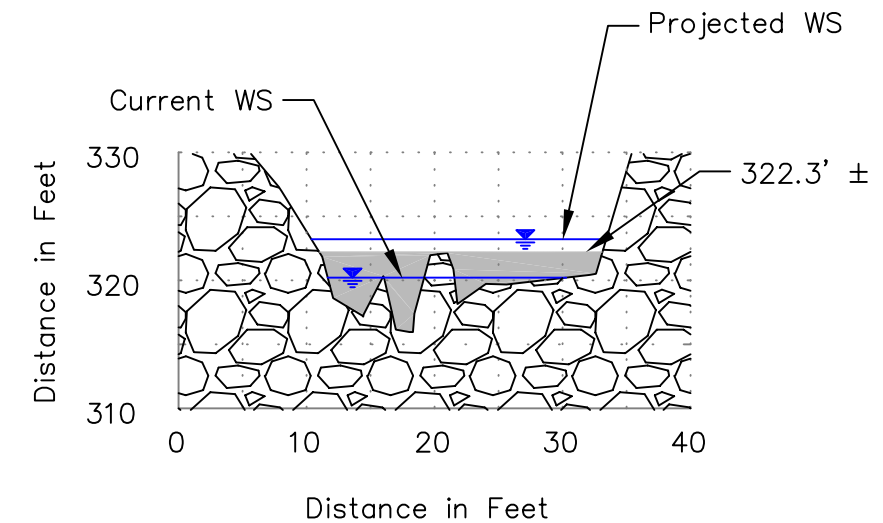
NOTES

- 1) Vertical Datum is NAVD 88, Feet
- 2) Survey performed in 2000.



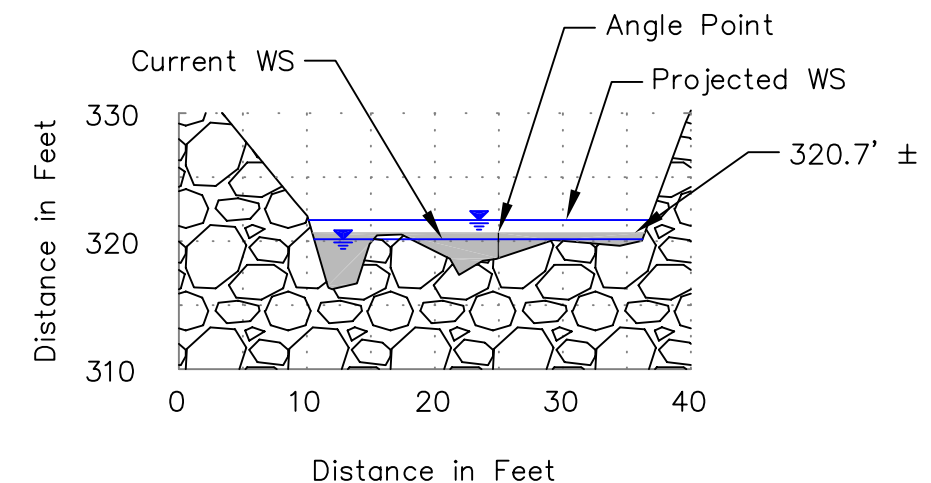
**Gradient Control Structure
1 of 1
(Alternative 3 or 4)**

(Looking upstream)
Scale: 1" = 15'



**Gradient Control Structure
1 of 2
(Alternative 3 or 4)**

(Looking upstream)
Scale: 1" = 15'



**Gradient Control Structure
2 of 2
(Alternative 3 or 4)**

(Looking upstream)
Scale: 1" = 15'

NOTES

- 1) Vertical Datum is NAVD 88, Feet.
- 2) Survey performed in 2000.

Appendix A Table of Contents

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Iron Canyon and Bear Hole Fish Passage Project on Big Chico Creek December 7, 2000 Meeting Notes

Attendees:

John Icanberry, USFWS
Steve Thomas, NMFS
Cindy Watanabe, DFG
Paul Ward, DFG
Dave Rose, DFG
Kevin Dossey, DWR
Scott Kennedy, DWR
Bill McLaughlin, DWR

General

- A clear narrative explaining the logic and process used to narrow down the alternatives and justifying the selected alternative needs to be included in the final preliminary engineering report for the investigation.
- Exceedance curves for historical flows should be generated to estimate potential passage delays.
- If alternative 2 or 3 is ultimately selected, there is a possibility that the DFG Elk Grove Screen Shop crew may be willing to do the construction work.
- The issue of ownership and maintenance of the structures at Iron Canyon and the potential proposed structure at Bear Hole will need to be resolved prior to seeking funding for the project.

Iron Canyon

- These 8 alternatives for Iron Canyon were presented:
 - Alternative 1 - Do nothing.
 - Alternative 2 - Make minimal improvements to the existing structure.
 - Alternative 3 - Make minor improvements to the existing structure.
 - Alternative 4 - Make major improvements to the existing structure.
 - Alternative 5 - Build hybrid facilities.
 - Alternative 6 - Build new fish ladder.
 - Alternative 7 - Build gradient structure.
 - Alternative 8 - Trap and relocate fish.
- Very rough, order of magnitude costs for the alternatives at this point are:
 - Alternative 1 - \$ 0
 - Alternative 2 - \$ 55,000
 - Alternative 3 - \$ 550,000
 - Alternative 4 - \$ 2,000,000
 - Alternative 5 - no estimate
 - Alternative 6 - \$ 5,500,000
 - Alternative 7 - \$ 3,500,000

- Additional resting pools should be provided if possible for alternatives 3 or 4.
- Cost vs. risk of the alternatives should be addressed.
- For Iron Canyon, it was decided that alternatives 2, 3, and 4 should be further investigated. Alternative 2 would focus on fixing the existing structures, alternative 3 would focus on 2' or less jumps for the entire fish ladder and achieving required leaping depths and energy dissipation at a design flow of 10 cfs, and alternative 4 would focus on 1½' or less jumps for the entire fish ladder and achieving required leaping depths and energy dissipation at a design flow of 10 cfs.
- Alternatives 1, 5, 6, 7, & 8 will not be further investigated. Alternatives 1 and 8 do not meet the goals of restoration, alternative 5 would not provide a suitable solution, and alternatives 6 and 7 are too high in cost for the risk with respect to the life of the project.
- For alternatives 3 and 4, DWR will look into constructing a new weir between weirs 7 and 8 vs. trying to plug the large hole in the weir 8 group to gain additional head in this area.
- At the exit, an existing concrete plug will likely need to be raised or replaced to prevent the potential of fallback.
- The use of steel caps will be utilized where appropriate to minimize the amount of concrete that would need to be placed.
- DWR will obtain additional information on the use of a silica gel for plugging leaks in the existing fish ladder.

Bear Hole

- These 7 alternatives for Bear Hole were presented:
 - Alternative 1 - Do nothing.
 - Alternative 2 - Enlarge constriction(s).
 - Alternative 3 - Enlarge constriction(s) and add gradient structure(s).
 - Alternative 4 - Add gradient control structure(s).
 - Alternative 5 - Build gradient structure.
 - Alternative 6 - Build new fish ladder.
 - Alternative 7 - Trap and relocate fish.
- For Bear Hole, it was decided that alternatives 2, 3, and 4 should be further investigated.
- Alternatives 1, 5, 6, and 7 will not be further investigated. Alternatives 1 and 7 do not meet the goals of restoration and alternatives 5 and 6 were thought to be extreme for improving fish passage at the site.
- The group felt that 2 structures instead of 1 should be designed into alternatives 3 and 4. The approximate 2½' jump that would exist with one structure was thought to be excessive. Two structures would reduce the jumps to approximately 1½' each.

The next meeting was not scheduled but will likely occur in January or February of 2001.

**Iron Canyon and Bear Hole Fish Passage Project on Big Chico Creek
May 9, 2001 Meeting Notes
DRAFT**

Attendees:

John Icanberry, USFWS
Steve Thomas, NMFS
George Heise, DFG
Paul Ward, DFG
Dave Rose, DFG
Curtis Anderson, DWR
Scott Kennedy, DWR
Bill McLaughlin, DWR

General

- The geology memorandum by DWR Project Geology was finalized on March 28, 2001. The memorandum summarizes that alternatives involving repair of existing structures are feasible and that any additional minor geology work can be done during final design or at the time of construction. Alternatives involving building significant new structures or modification of boulders would require an additional detailed geologic investigation.
- The environmental write-up will be completed after a preferred alternative is selected. Thus far, there haven't been any significant environmental issues.
- The photogrammetry work was completed April 2001. The final product is a mosaic beginning downstream of Bear Hole and extending upstream of Iron Canyon.
- The December 7, 2000 meeting was summarized.

Iron Canyon

- Alternative 4, which focuses on 1.5' drops or less between pools was discussed by DWR. It was pointed out to the group that trying to accomplish 1.5' drops would likely involve major work such as modifying the large boulder piles at the lower and upper sections of the existing fish ladder. This would result in a dramatic increase in cost due to items such as: additional geologic investigation, surveying, blasting/excavation of boulders, stabilization of boulders, and removal and reconstruction of existing structures. The group would like DWR to provide a cost estimate that is more detailed than an order of magnitude cost.
- Alternative 3, which focuses on 2' drops or less between pools was discussed by DWR. This would include repairing the existing structures and minimizing construction of new structures and meet standards and criteria where feasible. At 10 cfs, leaping depth requirement can be met throughout the fish ladder and energy dissipation can be met or almost met throughout the fish ladder. DWR will provide information on the level of energy dissipation that can be met for each of the pools with this alternative. The preliminary cost estimate for alternative 3 is about \$500,000.

- During the previous meeting, it was suggested that any pool volumes that could be increased to provide larger resting areas should be done for alternatives 3 and 4. Currently, pools 1, 6, 7, 8, and 10 are the only pools that have larger than normal volumes for resting. It appears that pool 13 is the only one that could be slightly increased.
- To seal the leak in pool 10, DFG suggested that the repair should be flexible to account for minor geologic shifting. DFG would like all pools to be “self-contained” or well sealed to ensure that water entering the fish ladder also exits the fish ladder. One of the objectives in alternatives 3 and 4 is to seal all of the leaks that have accumulated in the existing fish ladder over time.
- For alternatives 3 and 4, two methods to repair the ineffective weir 8 were presented by DWR to gain additional head in this area. One solution is to plug the tunnel that exists within a large boulder that makes up a portion of weir 8. The other option would be to construct a new weir between weirs 7 & 8 that would also included raising the left bank side of weir 7. It was suggested that a new weir located close to the exit of pool 6 would be preferable.
- DFG would like DWR to investigate different weir configurations such as vertical slots or notched weirs that could benefit passage in certain portions of the existing fish ladder for alternatives 3 and 4. DFG discussed an idea to utilize a “ramping” effect to help passage in certain portions of the existing fish ladder. DWR requested information from DFG regarding this technique.
- DWR discussed methods to raise the headwater pool for alternatives 2, 3, and 4 in the new structure above the exit of the fish ladder. The structure could be made up of rocks or a concrete structure. A concrete structure with flashboards may be preferable since it will be necessary for this structure to be adjustable.
- DWR suggested that the small concrete plug upstream of the fish ladder exit should not be raised as previously stated. The thought is that raising the plug would allow more water into the ladder as flows increase, which would not be a desired effect. Making this an adjustable structure may be more appropriate.
- Alternative 2, which focuses on minimal repairs to the existing fish ladder to make it operational again was not discussed. An updated preliminary cost estimate of about \$100,000 was given.

Bear Hole

- Alternative 2 for Bear Hole, which involves enlarging the constriction, was discussed by DWR. It is likely that the creek bed above the constriction and various sized boulders affected by significantly enlarging the constriction would need to be stabilized to prevent a fish passage problem upstream. A concern with this alternative is to not drastically increase velocities or decrease depths at low flows through this section. A rough cost estimate was given of about \$90,000.
- Alternative 4 for Bear Hole, which involves constructing 1 or 2 gradient control structures downstream of the constriction was discussed by DWR. This option would improve fish passage without enlarging the constriction or needing to address creek bed stability issues. The placement of 2 structures would create jumps of about 1.5’ compared to a current jump of 4’ to 4.5’ at low flows. The upstream

structure would be about 6.25' feet high and the downstream structure would be about 4.5' high. A rough cost estimate was given of about \$95,000.

- Alternative 3 for Bear Hole involves placing the gradient control structures and enlarging the constriction. It doesn't seem necessary to enlarge the constriction significantly to further improve passage. It was suggested that possibly doubling the width of the existing constriction might be helpful. A rough cost estimate was given of about \$150,000, but could be reduced depending on the extent of the constriction enlargement.

The next meeting was not scheduled.

Iron Canyon and Bear Hole Fish Passage Project on Big Chico Creek July 5, 2001 Meeting Notes

Attendees:

John Icanberry, USFWS
George Heise, DFG
Paul Ward, DFG
Scott Kennedy, DWR
Bill McLaughlin, DWR

Iron Canyon

- DWR discussed items that were to be followed up on from the 5/9/01, sent out to the group on 6/5/01.
- DWR discussed an updated alternative 4 that would reduce the jumps between pools to 1.5'. The proposal is to add 5 additional weirs within the limits of the existing fish ladder into pools 12, 7, 6, 5, and either plugging weir 8 or adding an additional weir into pool 7 or 8.
- For alternatives 3 and 4, DWR discussed if leaping depth and what levels of energy dissipation would be met. The required leaping depth would be met for all pools with both alternatives. For alternative 3, 4 ft-lb/ft³/sec of energy dissipation would be met with 10 of the 16 pools. With alternative 4, 13 of 21 pools would meet the recommended energy dissipation.
- DWR discussed the concept of notching existing weirs to a 3' wide by 2' deep opening that could accommodate contracted/suppressed weirs, vertical slots, sloped ramps, or other weir types. The group felt that the flexibility this would provide would be beneficial. DFG suggested a 2.5' deep opening to give more operational range.
- DFG asked that energy dissipation in pools be limited to about 8 ft-lb/ft³/sec. This will require slightly raising the energy dissipation in adjacent pools to reduce the higher ones to 8 ft-lb/ft³/sec or less.
- DWR proposed the idea of lowering the invert of the exit weir (weir 17) by 1' and making it adjustable rather than building a new structure in the creek to control the headwater pool. It was also noted that flow to the fish ladder could only be controlled up to about 50 cfs for alternative 3 and about 30 cfs for alternative 4 in the creek before the design head differential or energy dissipation would begin to be exceeded. The group decided that making the exit weir adjustable would be the better option than a new structure in the creek.
- DFG emphasized the need to address stabilizing the floor of the headwater pool upstream of the exit weir and rebuilding the concrete sandbag plug just upstream of the exit.
- DFG suggested that the left bank wall of pool 3 should be strengthened to withstand the force of water flowing into against it.
- DWR gave an updated preliminary cost of \$650,000 for alternative 3 and \$760,000 for alternative 4.
- The group decided that alternative 4 is the preferred option at this time.

Bear Hole

- DWR asked for input on whether the gradient control structures should include a low flow notch or not. The structures without a notch would be submerged during low flow conditions. The group felt that the structures should not include the notch but that slightly sloping the structures may be desirable. This would be determined in final design.
- DWR asked for clarification as to whether a slight enlargement of the upper constriction was desired by the group. Enlargement of the upper constriction isn't needed for improved fish passage. The group felt that the enlargement wasn't needed but would be open to that possibility during final design. This means that alternative 4 for Bear Hole is the preferred alternative at this time.

General

- DFG asked when a draft report could be completed to begin the review process and to discuss the project with the City of Chico and the Big Chico Creek Watershed Alliance. DWR will try to have the first draft to be reviewed by DFG, NMFS, and USFWS in the next couple of weeks.
- Steve Thomas from NMFS was not able to attend the meeting. He will need to be informed of the meeting to see if he concurs with the group. George Heise will contact and update Steve on what occurred at the meeting.

A future meeting was not scheduled.

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Average Daily Flow Exceedances and Average Monthly Flows	B-2
Monthly Average Daily Flow Exceedance Charts.....	B-3
Frequency Curve.....	B-15

Big Chico Creek Average Daily Flow Exceedance - Monthly Summary (Water Years 1931-1986 & 1997-1998)

Flows in cfs

	October	November	December	January	February	March	April	May	June	July	August	September
90%	20	23	27	33	53	68	52	33	25	20	18	19
50%	26	34	54	107	185	188	127	64	39	28	24	24
33%	29	45	112	225	317	277	204	91	48	31	27	25
20%	31	71	224	405	543	397	315	129	55	35	30	28
10%	38	145	527	812	1010	678	447	189	69	41	32	31
5%	52	285	948	1380	1580	1100	633	236	88	45	35	34

Big Chico Creek Average Monthly Flows (Water Years 1931-1986 & 1997-1998)

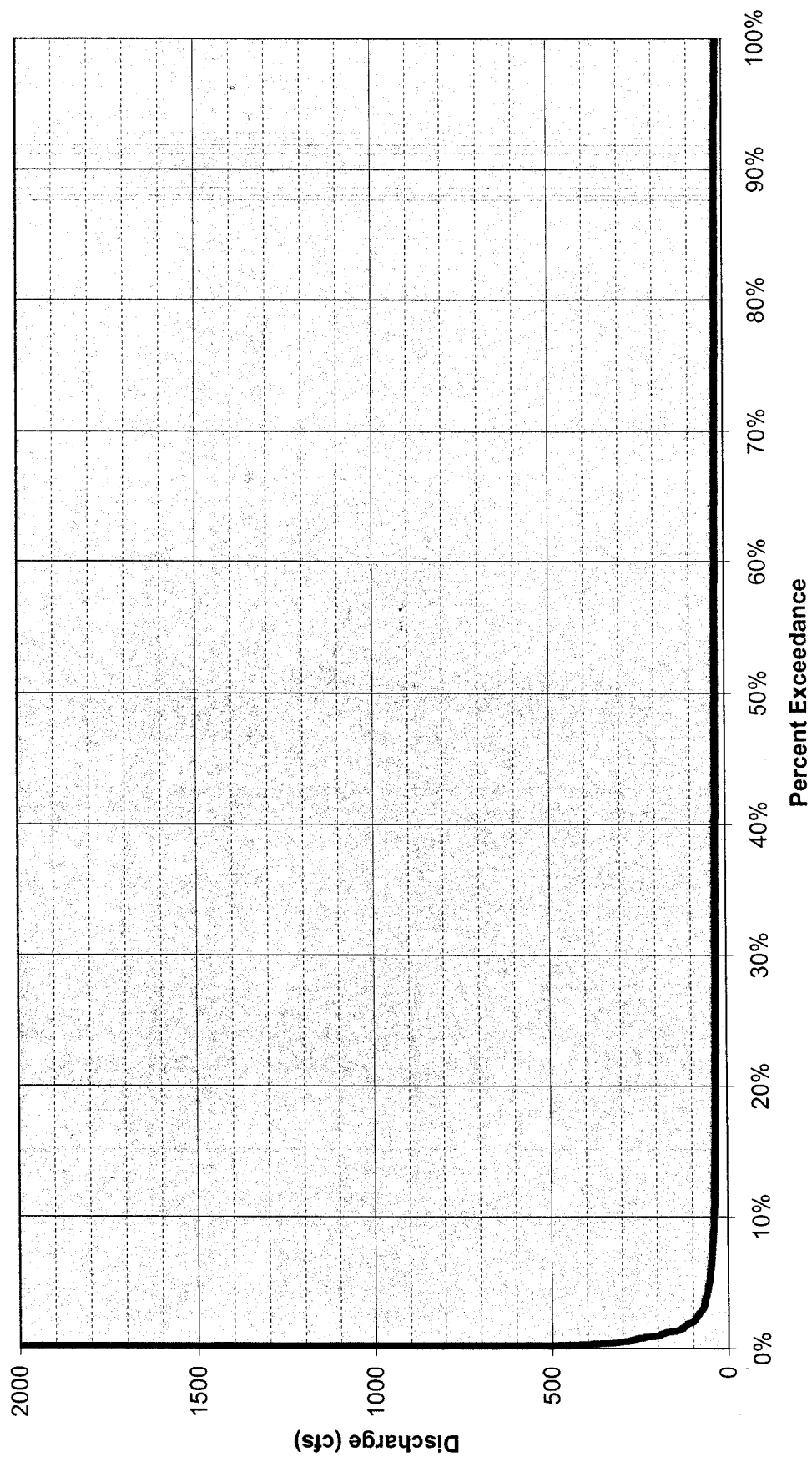
Flows in cfs

	October	November	December	January	February	March	April	May	June	July	August	September
Avg.	35	83	214	328	409	321	221	93	46	29	25	25
Max	3330	3270	7190	6140	7070	5300	4880	1250	366	83	51	201
Min	16	17	18	21	18	28	17	20	17	14	14	15

Note:

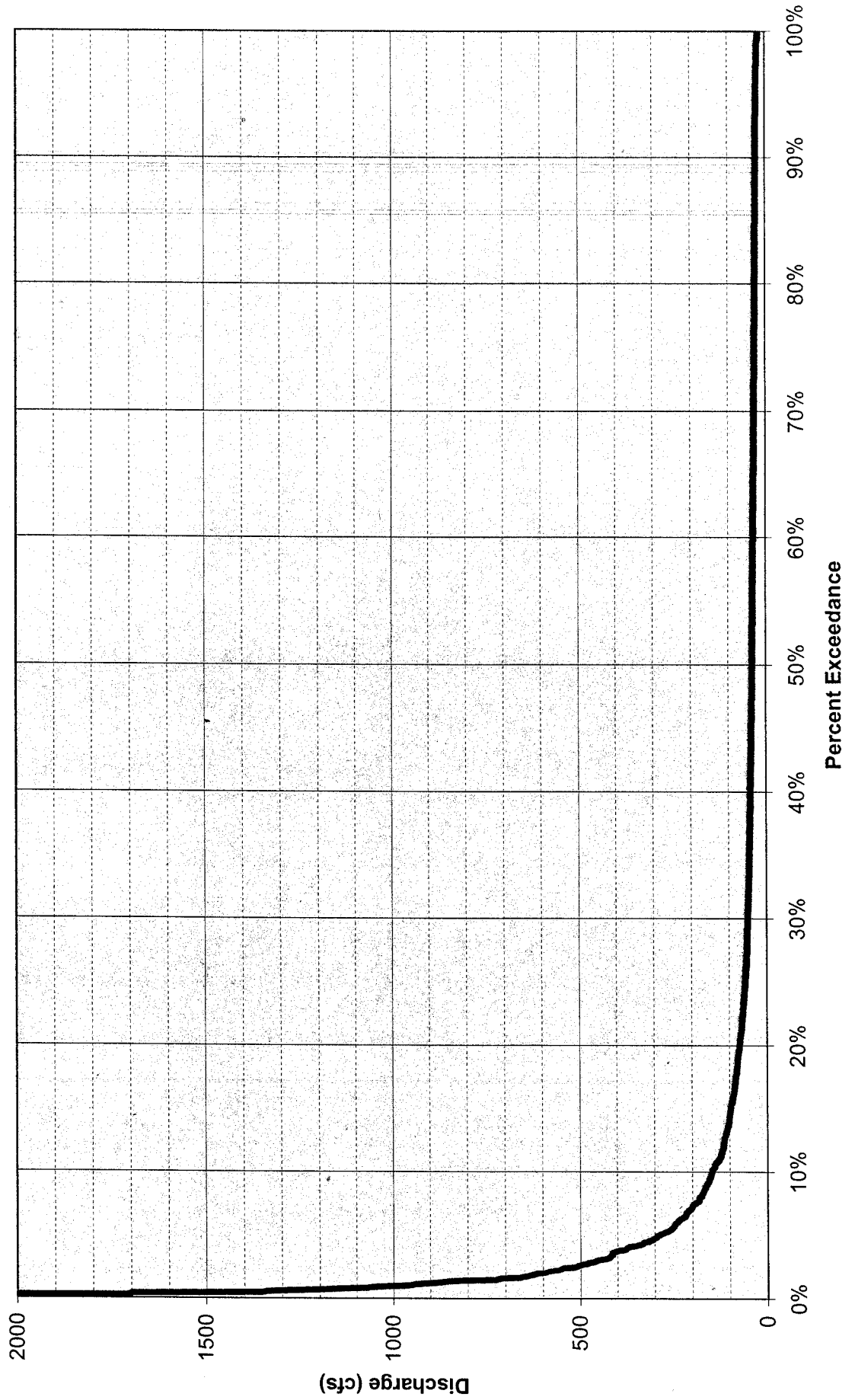
No flow records from 12/9/96 to 12/13/96, 12/26/96 to 12/31/96, 1/1/97 to 1/8/97, 1/22/97 to 1/31/97, 1/12/98, 2/1/97 to 2/8/97, 2/3/98, and 2/7/98.
 Data from water years 1931-1986 are from the USGS gaging station #11384000 which was located about 3/4 of a mile downstream of Bear Hole.
 Data from water years 1996-1998 are from the DWR gaging station which is located about 1 mile downstream of the abandoned USGS gage.

**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)
October**

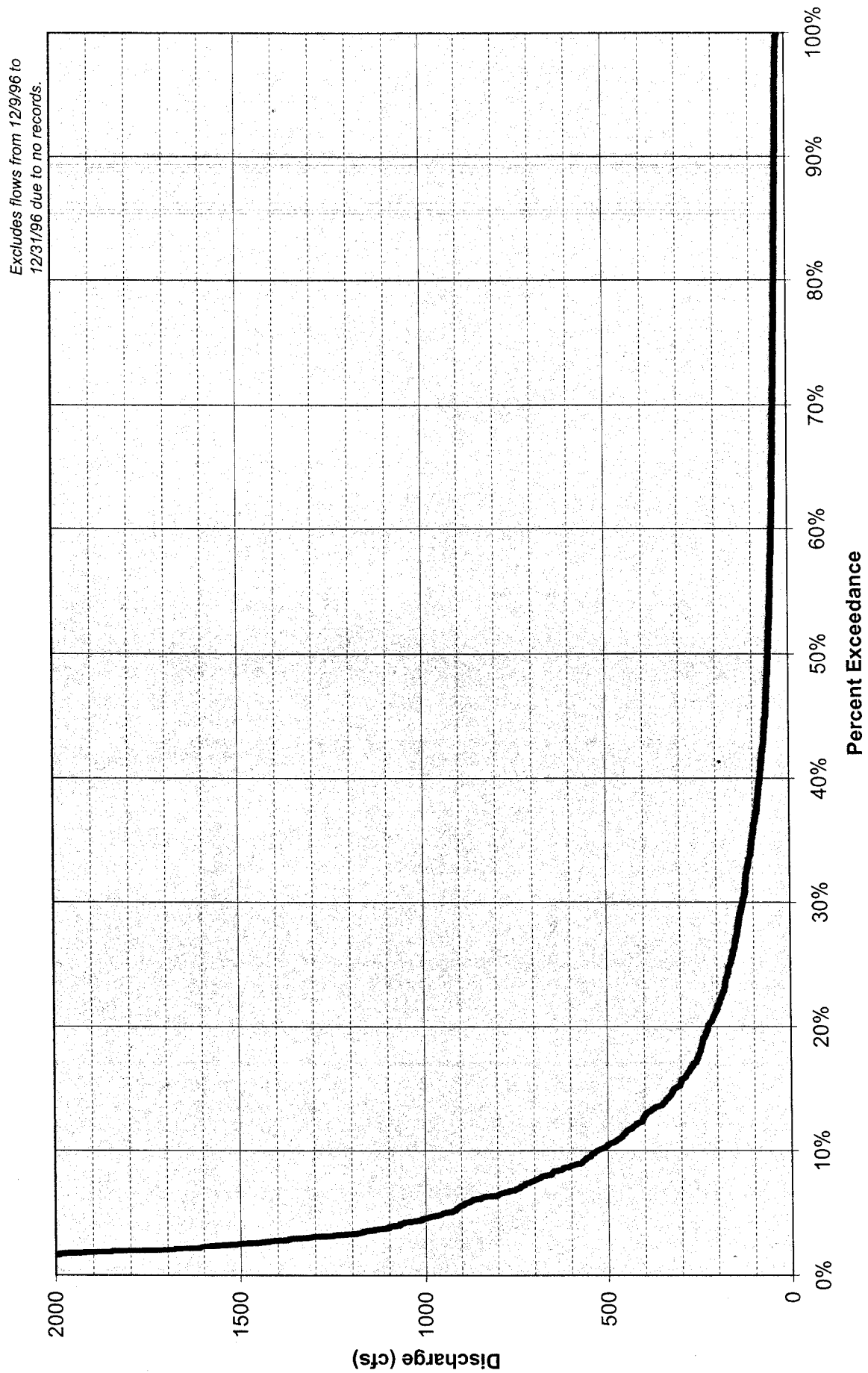


**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)**

November



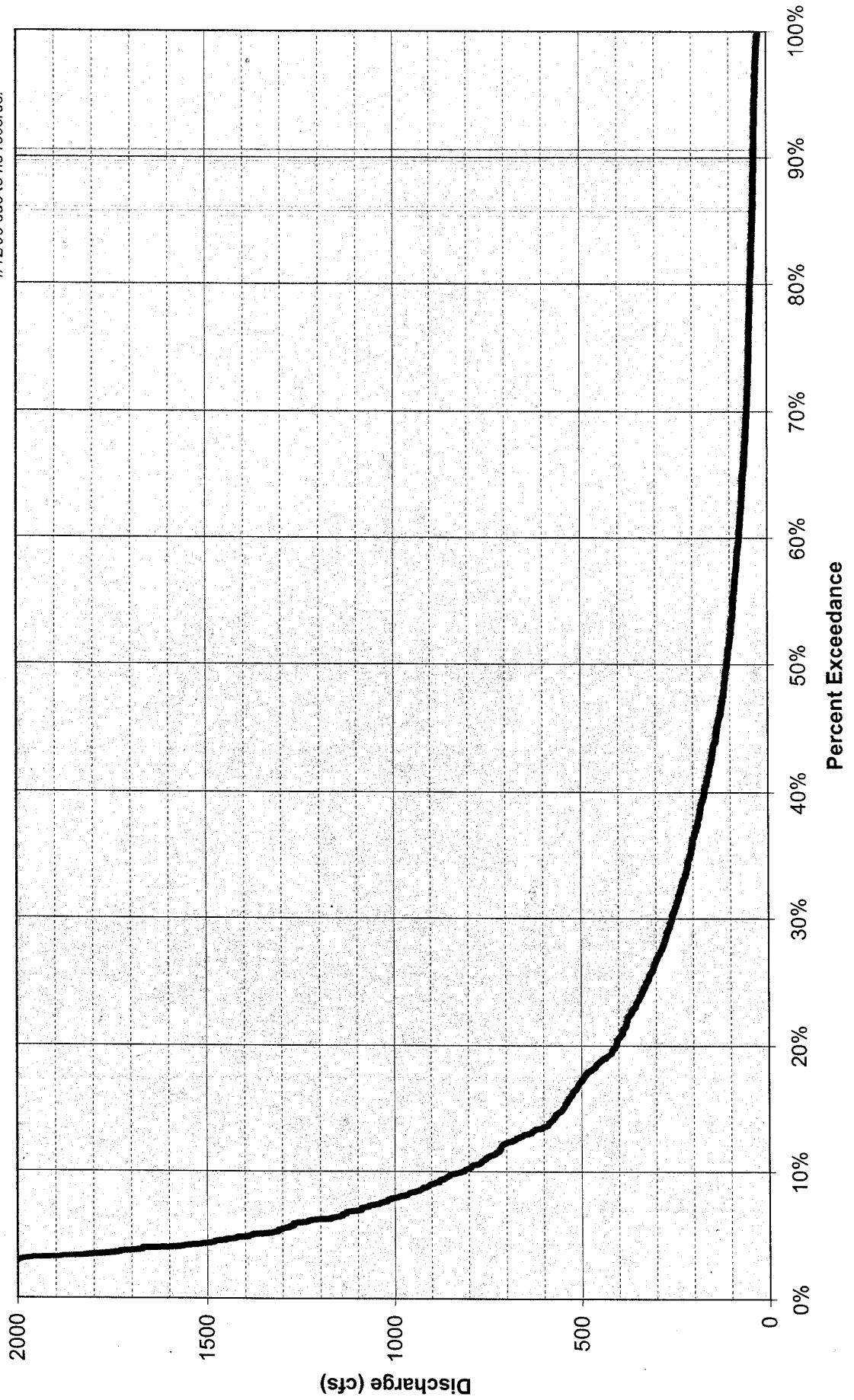
**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)
December**



Big Chico Creek Average Daily Flow Exceedance (Water Years 1931 to 1986 & 1997 to 1998)

January

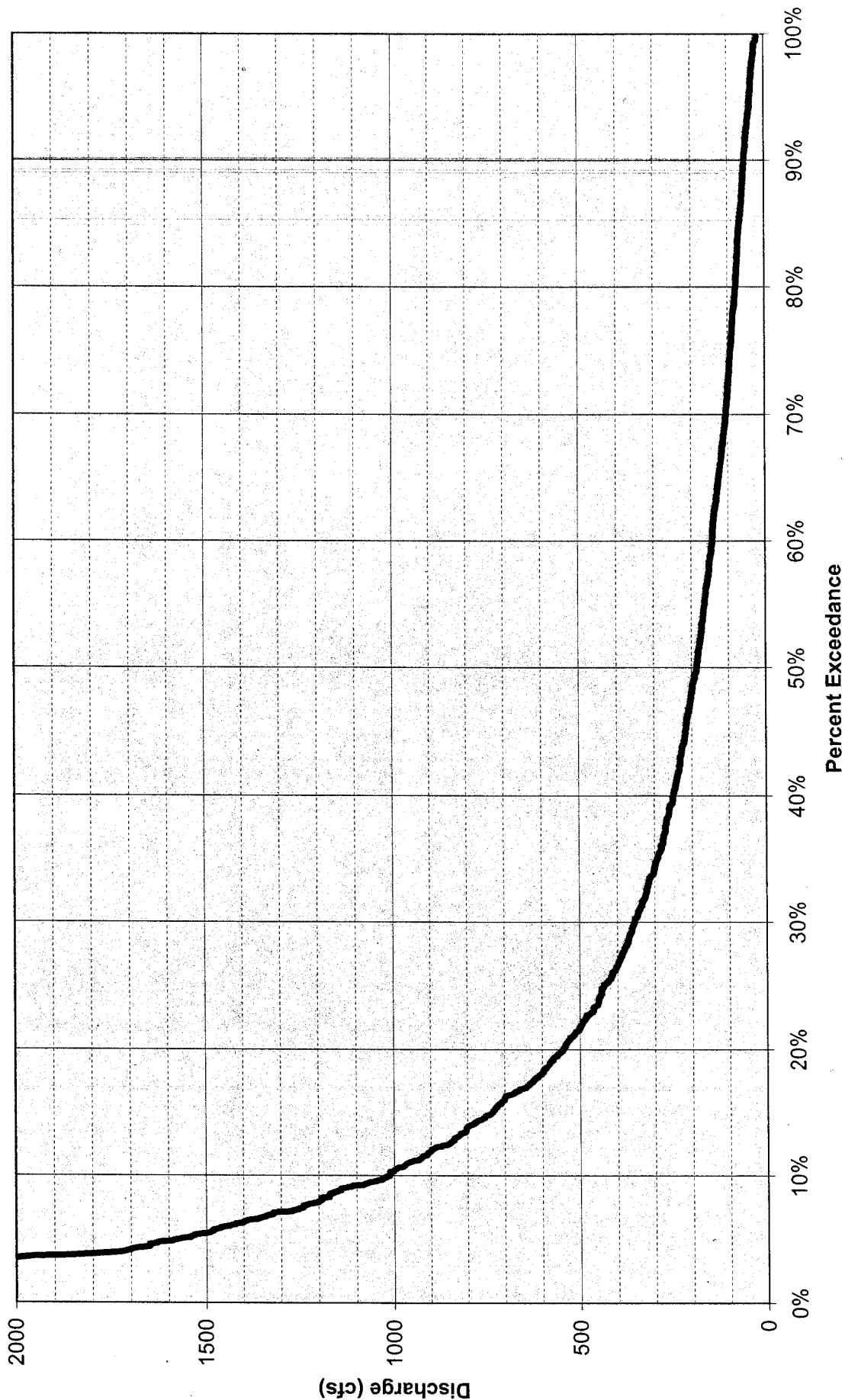
Excludes flows from 1/1/97 to
1/8/97, 1/22/97 to 1/31/97, and
1/12/98 due to no records.



Big Chico Creek Average Daily Flow Exceedance (Water Year 1931 to 1986 & 1997 to 1998)

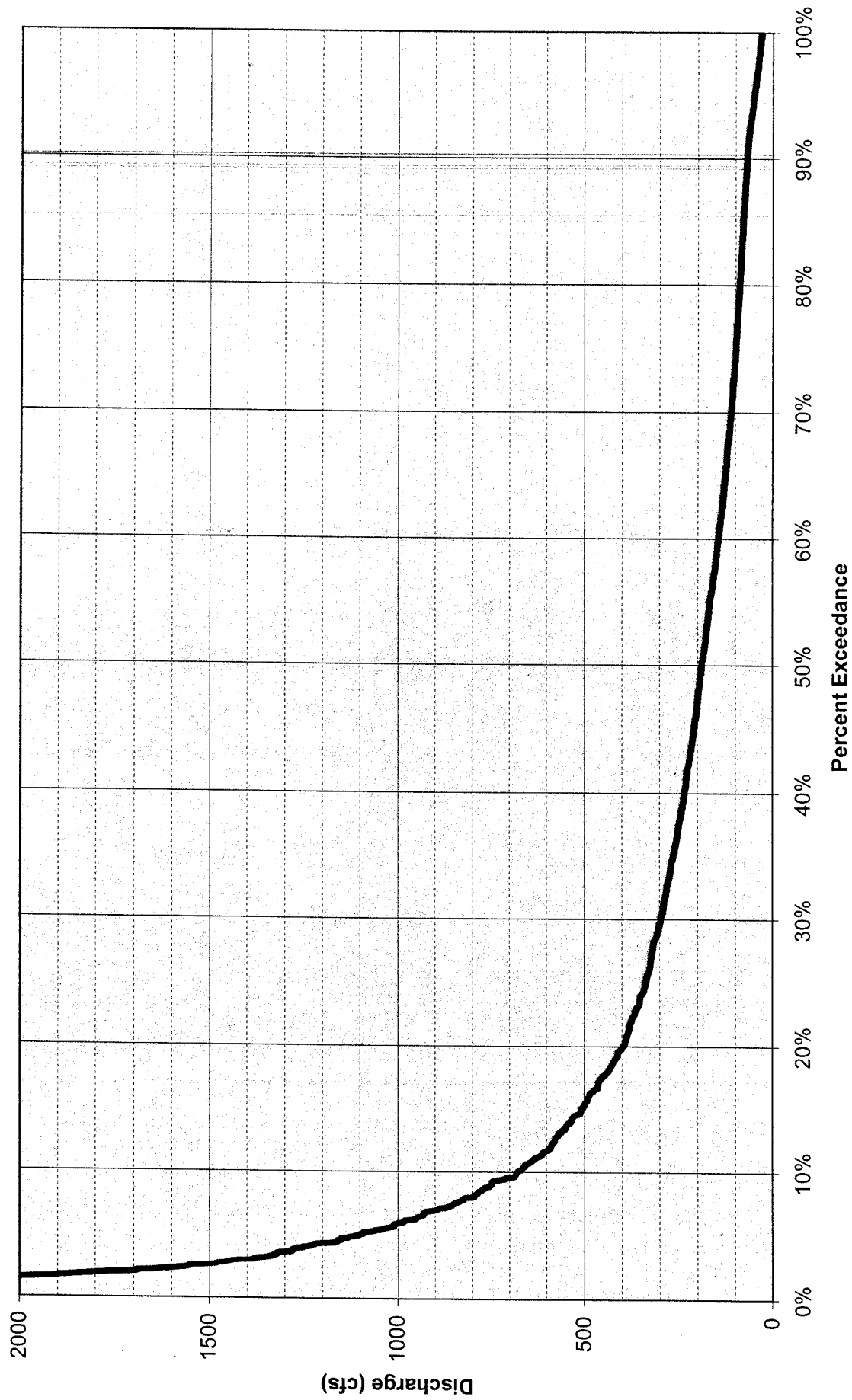
February

Excludes flows from 2/1/97 to
2/2/97, 2/3/98 to 2/8/98, 2/3/98,
and 2/7/98 due to no records.



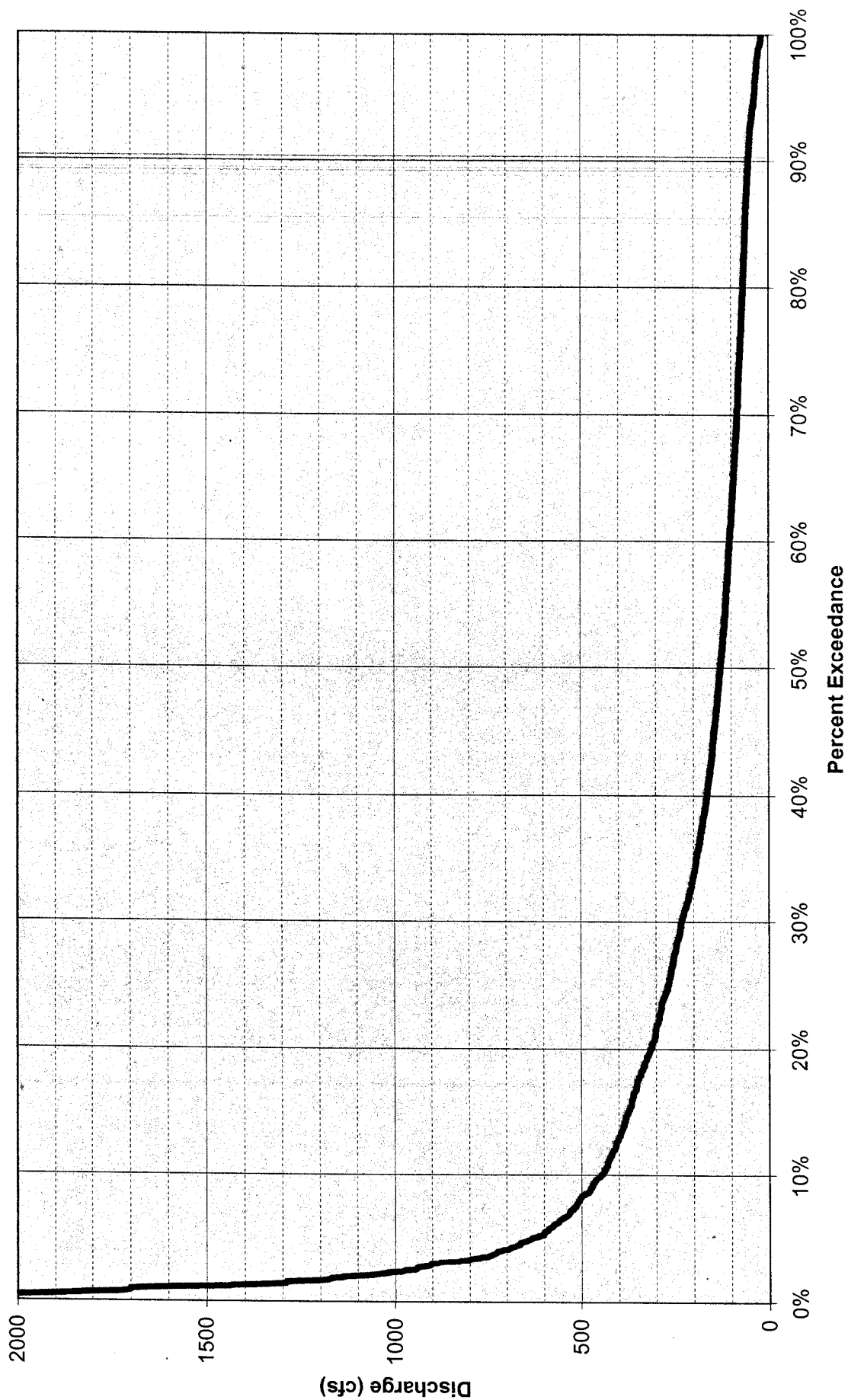
Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)

March



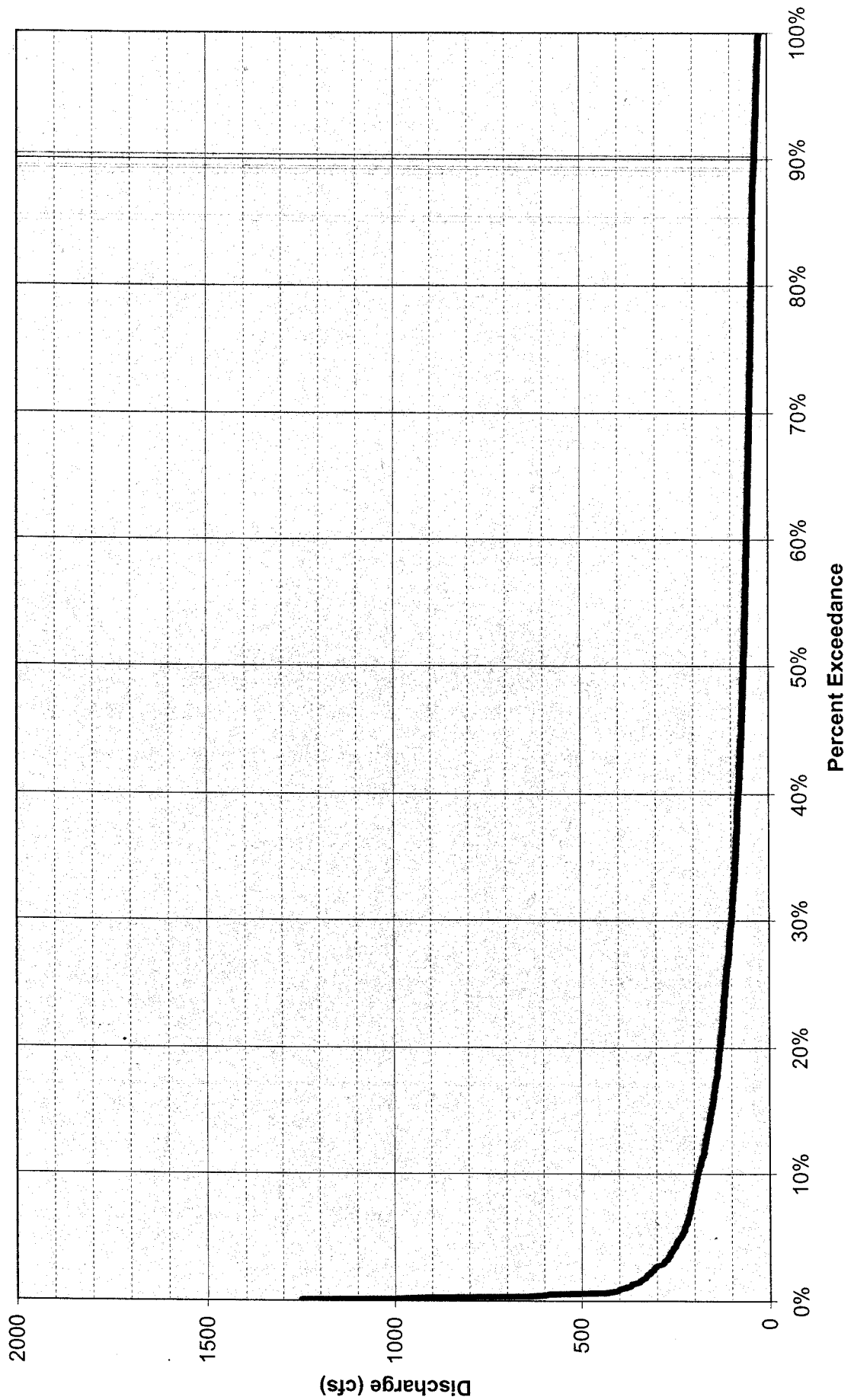
**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)**

April



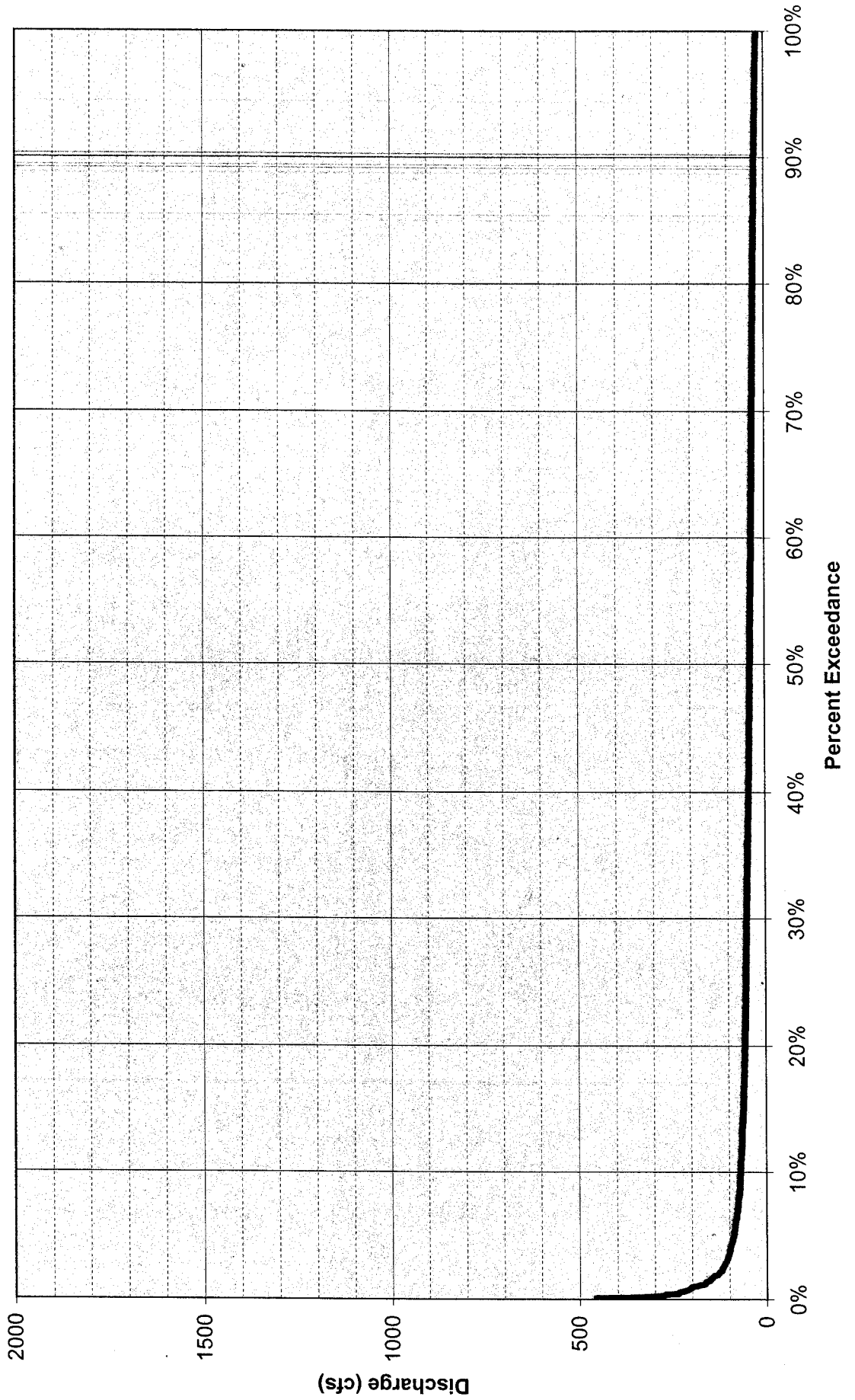
**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)**

May



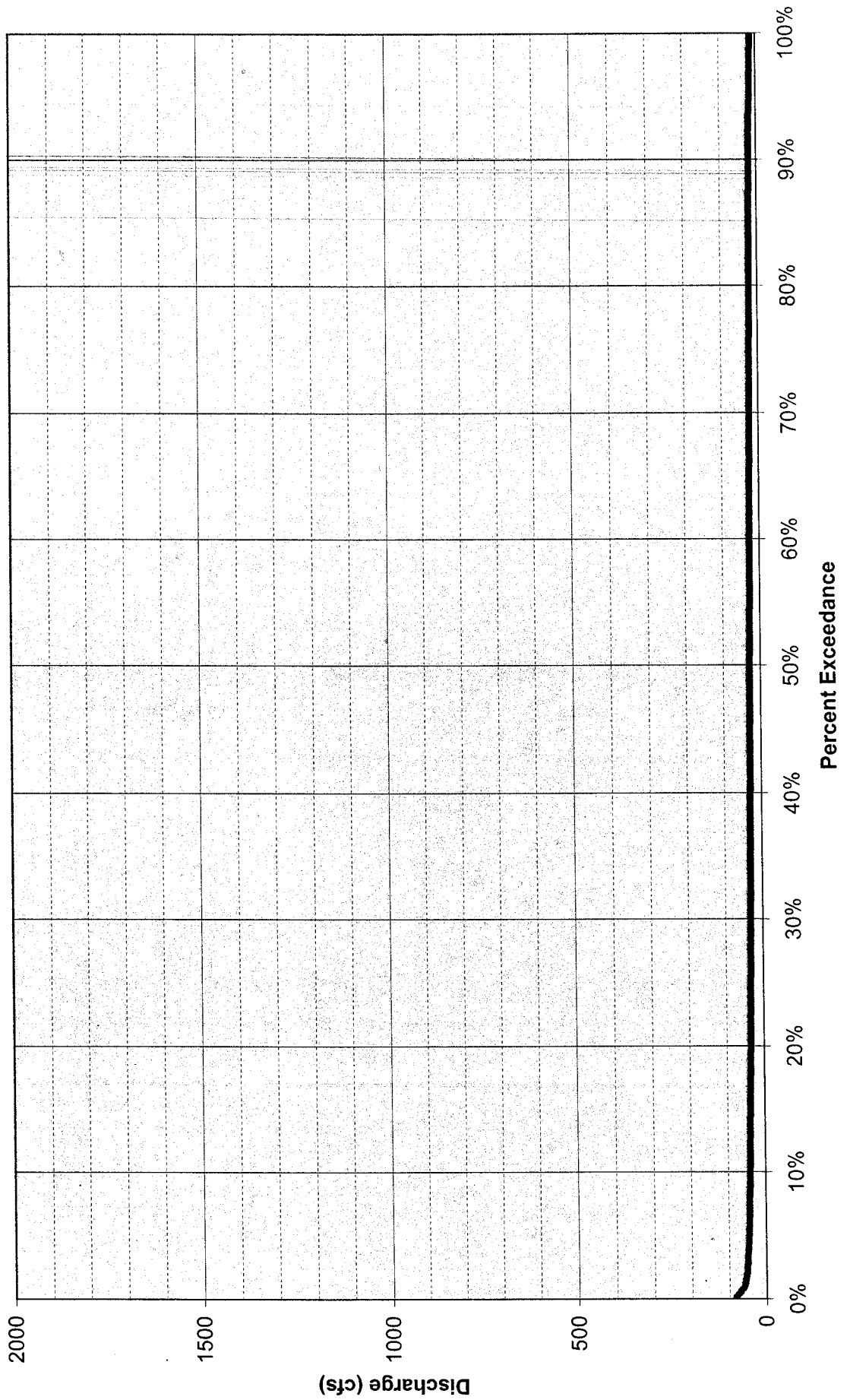
**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)**

June



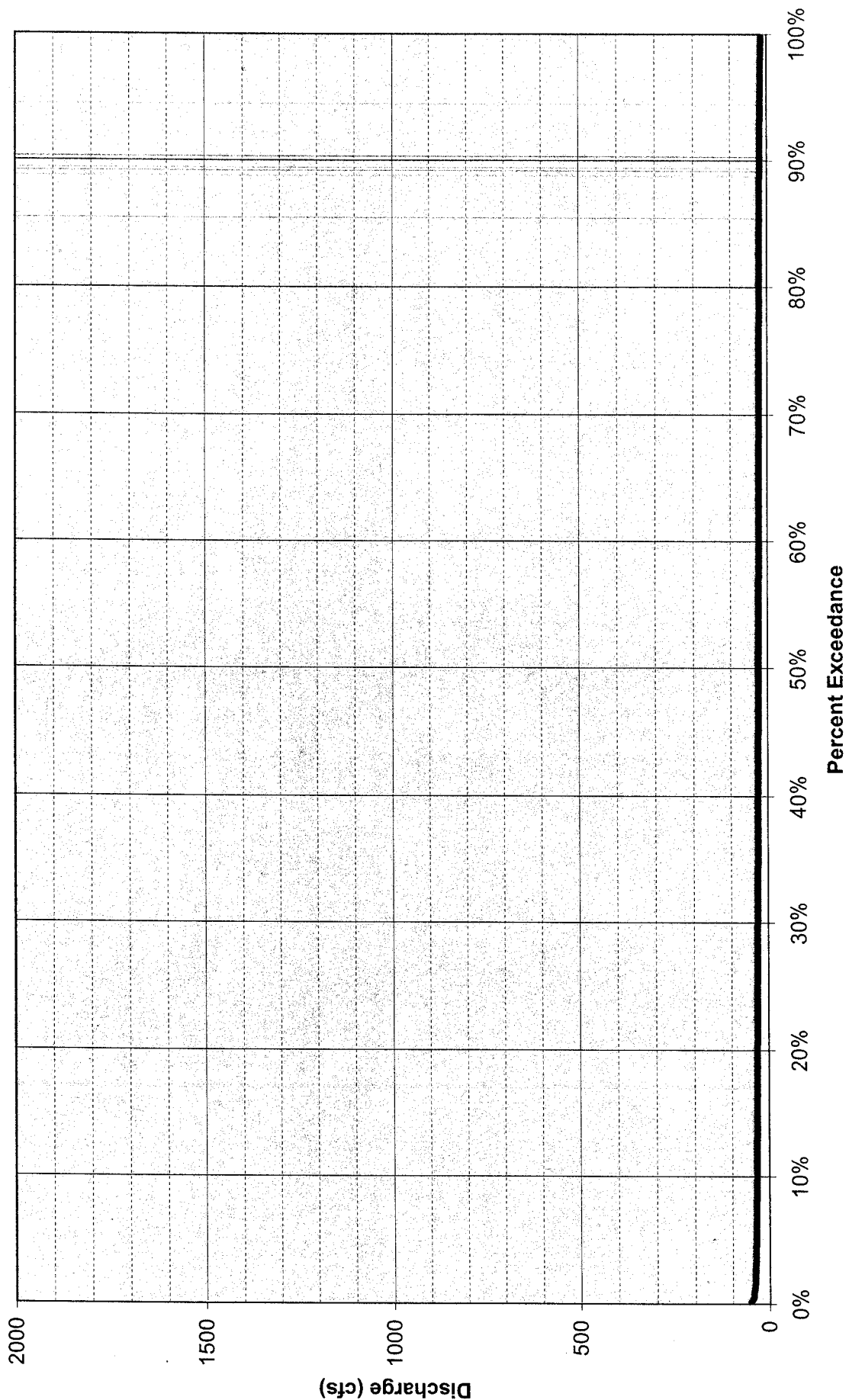
**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)**

July

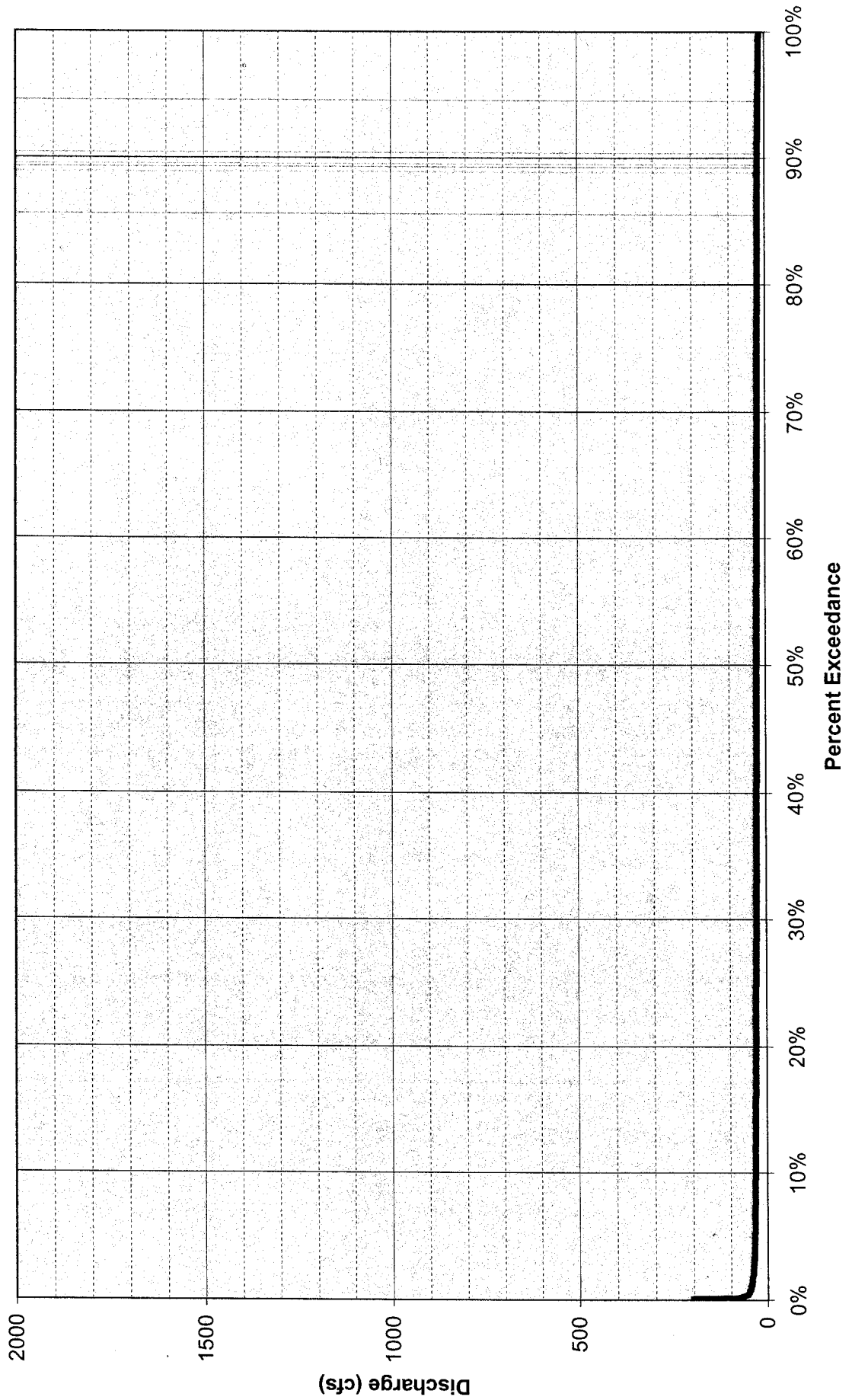


**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)**

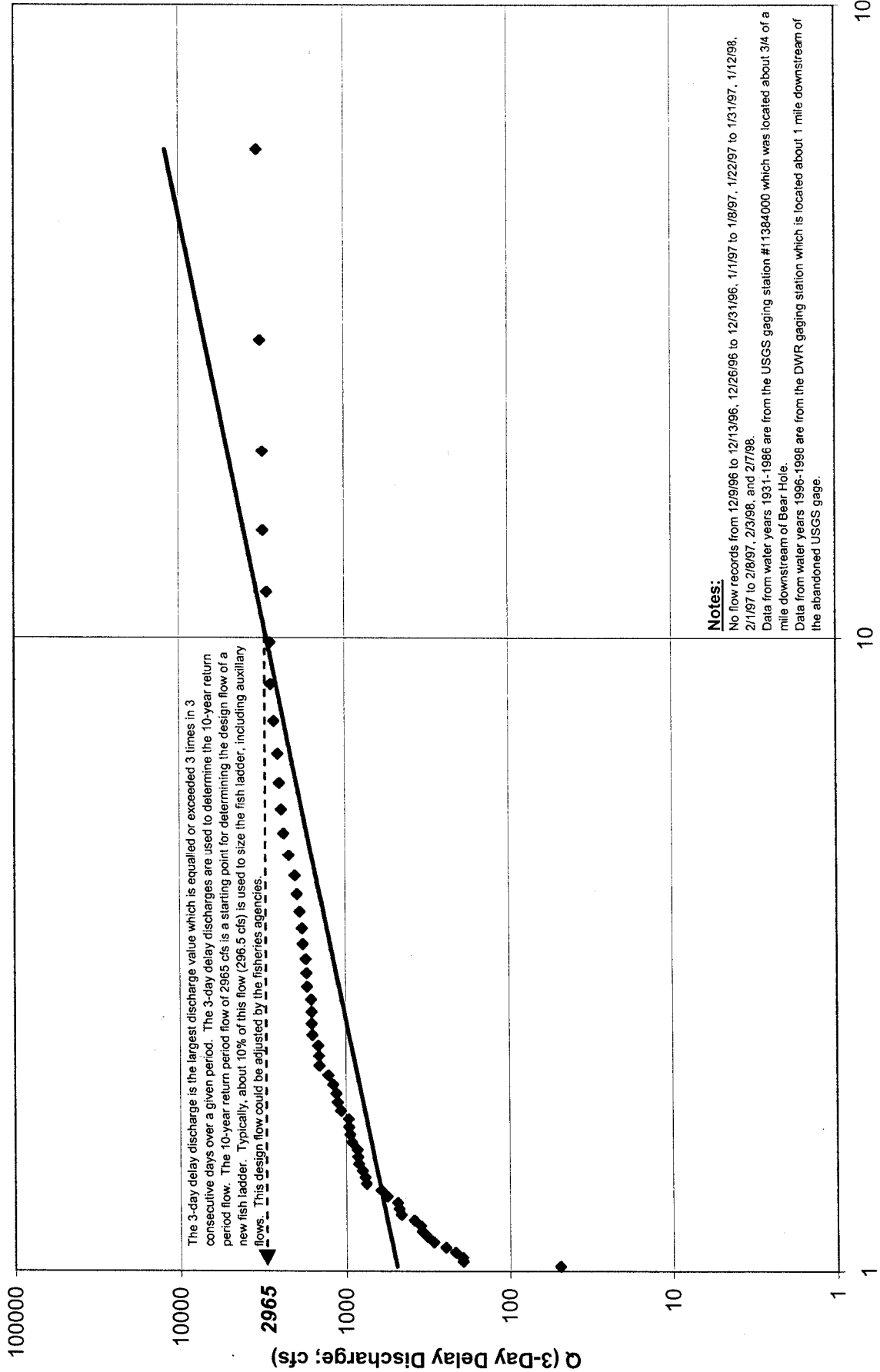
August



**Big Chico Creek Average Daily Flow Exceedance
(Water Years 1931 to 1986 & 1997 to 1998)
September**



Big Chico Frequency Curve Water Years 1931 to 1986 and 1997 to 1998



Appendix C Table of Contents

Preliminary Geology Memorandum	C-2
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Memorandum

Date : March 28, 2001
To : Bill McLaughlin
Engineering Studies Section
Northern District
Division of Planning and Local Assistance
Steve Belluomini
Project Geology Section/Division of Engineering
From : ~~Department of Water Resources~~
Subject: Geological Feasibility of Constructing New Facilities and Repairing Existing Structures on Big Chico Creek

Project Geology
Report No. 94-00-14

Introduction

The purpose of this memorandum is to provide a geological review of the proposed alternatives for the proposed Bear Hole and Iron Canyon Fish Passage Project on Big Chico Creek. The project goal is to improve fish passage for spring-run-Chinook salmon and steelhead trout past Iron Canyon and Bear Hole on Big Chico Creek over a greater range of surface water flow conditions. As shown on the attached location map, the project site is located in Upper Bidwell Park on City of Chico land.

The Bear Hole portion of the proposed alternatives include enlarging the existing constriction in the creek channel and adding structures in the creek to change water surface levels. The Iron Canyon portion of the proposed alternatives include repairing existing facilities, ranging from minimal to major improvements, repairing existing facilities and building new facilities including constructing a new fish ladder.

This memorandum is the result of a September 6, 2000 request for information from Bill McLaughlin to Frank Glick concerning the geological feasibility of constructing new facilities and repairing existing structures on Big Chico Creek. Specifically, the Northern District request was for information on the following:

- stability of geologic features in the project areas,
- the geologic feasibility of grading (pool deepening or filling),
- the feasibility of construction in the areas of proposed structures,

- opinions regarding creek bed stability,
- dewatering,
- and the stability of potential staging areas on the canyon rim.

Although there is a high risk of construction difficulties due to the geological conditions at this site, all of the proposed work is geologically feasible. No additional geologic studies are needed at this time.

Two field visits were conducted during Fall 2000 with Northern District staff Bill McLaughlin and Scott Kennedy, and Steve Belluomini from Project Geology. This memorandum was not written to be a stand alone document; it will be included as an appendix to the Preliminary Engineering Technical Report being prepared in the Northern District.

Site Geologic Description

The site in Big Chico Creek canyon consists of Lovejoy Formation basalt. The basalt is a very blocky, interlocked, partially disturbed mass with multifaceted angular blocks formed by four or more joint sets. Basalt rock fragments up to about 80 feet in maximum dimension are strewn on the canyon bottom.

Within the streambed, smaller instream sand and gravel material is present within the larger boulder-size material and in occasional pools. In some areas, the boulders lining the stream channel are so large, the depth to intact bedrock is unknown. The rock masses collectively constrict and control the amount and the direction of surface water and subsurface water flow within the Big Chico Creek drainage.

Bear Hole on Big Chico Creek

The main problem at Bear Hole appears to be a 6-foot ground surface elevation change across the upper constriction. A 4-foot to a 6-foot water surface elevation difference across the constriction is present during low stream flows and high stream flows. The constriction is in a high public access area in Upper Bidwell Park.

Bear Hole Alternatives

The Bear Hole alternatives include enlarging the upper and lower constriction by altering the large boulders and bedrock, and adding a new gradient control structure(s) downstream. In addition, filling in the channel downstream of the constriction to reduce the elevation change across the upper constriction is also being considered.

Removing rock to enlarge the constrictions is geologically feasible. When looking downstream, the right side of the constriction appears to be strong, blocky intact rock. On the left side of the channel, wedges or blocks of rock (boulders) are present. The stability of the boulders is unknown; at any time, the boulders could shift. To minimize the potential for boulder shifting on the left side of the channel during construction and after enlargement, rock bolts could be installed through the largest boulders into the material behind and underlying the boulders. Another option would be to install one or more arched steel plates to secure the top of the boulders on the left side of the channel to intact rock on the right side of the channel.

The construction of gradient structure(s) is geologically feasible. However, the presence of boulders on the left side of the channel and upstream should be considered in the development scheme. If the structures are built, periodic maintenance of each structure will probably be required. If the construction work is minor in nature, geologic mapping could be performed at the time of construction.

If the Bear Hole constrictions are enlarged without adding the gradient control structures, then the existing sand and gravel upstream of the constrictions may be susceptible to erosion and transport downstream. Predicting exactly how the sediment will respond to widening the creek channel is probably not feasible because of the lack of data correlating stream sediment transport and stream surface water flow at this location. However, it is reasonable to presume that movements will occur after widening.

If gradient control structures are not used, then filling in the channel downstream of the constrictions to reduce the elevation change across the constrictions is also being considered. Extensive filling in the channel with rock downstream of the constrictions is geologically feasible, but material that is placed in the channel should be large enough to resist shifting or movement downstream during high stream flows greater than 500 cfs.

Regardless of the methods chosen to change the site, erosion and depositional forces will work on the materials until a relatively "steady state" condition is reached. The site will not be free of long-term maintenance.

Iron Canyon on Big Chico Creek

The main problem at Iron Canyon is leakage through and under the existing fish ladders, loss of the channel flow line and flow direction relative to the location of ladders, and steep surface water gradients across boulders, obstacles in the creek, and constrictions forming the stream bottom. Some of the existing facilities are extensively damaged and worn to the extent that the fish ladder does not function as intended. The weirs in the upper section are generally not as eroded as much as the weirs in the lower section.

Iron Canyon Alternatives

The Iron Canyon alternatives include repairing and capping the existing damaged structures, replacing damaged fish ladder walls, excavating pools, adjusting the weir crest elevations, possibly plugging a natural "tunnel", and repairing leaks at existing walls. All of this work is geologically feasible.

Repairing and capping the existing damaged structures should be relatively easy to perform. Most of the weirs are relatively small and replacement should be easy except where adverse conditions may be present. An engineering geologist should be on-site to inspect the rock at foundation grade and to inspect the site for any loose material that should be removed or stabilized immediately prior to and during construction.

To replace damaged fish ladder walls, identifying adequate foundation support for new structures will be required if intact bedrock is not present at the ground surface. Any loose rocks smaller than three to four feet should be removed from the foundation. During construction, all exposed openings between rocks and any open fractures should be filled with concrete.

Some of the existing pools in Iron Canyon may be excavated to increase volume. The pool excavation depths range between 0.1 feet and about 5.5 feet. Most of the pools contain sand, gravel, cobbles, and boulders that can be easily removed. To maintain pool depth at all of the pools, periodic maintenance will probably be required.

Most of the excavations to remove sediment will be relatively easy because minimal pool deepening is required. In areas that contain large rock that cannot be removed easily, the rock can be broken down into manageable pieces by drilling and light blasting, by jack hammering, or by using a ram-hoe, in order to facilitate subsequent removal by hand. Light blasting will require a blasting plan and the plan can be managed to minimize disturbance to the surrounding areas.

In some areas, to enlarge the pools, removal of the pool walls may be required. The walls of the upper section of the fish ladder are primarily large boulders. In areas of wall removal, boulder stability is always an issue. The basic methods to promote stability on the canyon walls and in open sections of channel include boulder perimeter support using precut iron or pipe supports, or rock bolts. Partially excavating sections so that substantial support can be installed before excavating the full wall section may be required depending on the size and location of stream alteration. In other words, to do work, it may be necessary to support boulders surrounding the work area before the work can proceed. Immediately prior to altering the walls of pools, detailed geologic inspection and mapping should be done and structural engineering completed to design supports and develop a wall grading plan.

Water leakage is present between pools and into and out of the upper ladder section along most of its entire length. Other leaks occur in the lower section where the concrete meets rock, but the most significant leaks occur where sandbags filled with concrete were used in the original construction. The repair of leaks would include both sealing leaks where the existing concrete structures meet rock as described above, and sealing between the rocks that make up the walls of the ladder. Contact grouting in the dry using cement under carefully monitored pressure could be used to seal the base of walls that leak.

In all of the areas where concrete sandbags were used in the original construction, the walls should be replaced. The concrete-filled sandbags in Iron Canyon should be considered as temporary construction methods and not intended to be permanent features. Concrete filled sandbags are inexpensive and can be very effective. The existing concrete filled sandbags lasted many years.

Overall, the work in Iron Canyon must be performed in dry conditions. Water from this reach of the canyon will have to be diverted from its existing path where water interferes with construction, or access to construction areas.

A natural underwater passageway, known as tunnel "A", may be present because large rock blocks have bridged across the stream forming an elevated stream bottom. It may be possible to plug the tunnel opening by placement of boulders in the wet or plugging the opening with concrete in the dry. To understand the stability of the side walls and roof of the underwater passageway and delineate the geometry of the tunnel, detailed geologic mapping of the surface condition should be performed and mapping of the subsurface conditions should be performed when the site is dewatered during construction.

There is also a large cavity below Pool 10 where water can flow out of the pool. DFG has attempted repairs in the past, but did not have complete success. The size and the location of the void below Pool 10 was not delineated because it cannot be observed from the surface when water is present in the creek. Drill holes could be used to determine the approximate size and location of the void. During the engineering design and/or construction phases of work, it would probably be more desirable to direct resources for drilling to a grouting effort rather than spend the money on exploration.

If the problem at Pool 10 is not completely understood then a drawback to plugging the cavity at Pool 10 is that if it is done improperly, the pool bottom could drop out again. The stream is much deeper at this location than the apparent bottom of the pool. Grouting the void at Pool 10 could be done using cement grout or silicone grout. A disadvantage to grouting is that the work may require large volumes to achieve the desired result. Another disadvantage of grouting is that desirable fishway voids below the pool bottom may be inadvertently closed off. Ideally, all grouting at Iron Canyon should be performed in dry conditions. An advantage of silicone grouting is that it can be performed in the wet as long as there is very little or no flow. The cement grouting could be done in the wet, but would probably be more effective if accomplished in mostly dry conditions.

If grouting the void below Pool 10 is not desirable, it may be possible to bridge the opening to the void. Bridging could be accomplished by installing preformed concrete or steel plate cut to fit the area being bridged, and anchoring the concrete or steel to the surrounding boulders or rock. The purpose of the bridge would be to form a barrier, in order to retain the stream flow at the ground surface and at the desired elevation(s).

Near Pool 10 and in the upper section of the fishway, a very large slab of basalt about 80 feet in maximum dimension forms a cave section of the fish

ladder. The slab appears to be broken about mid point and it does not appear stable enough to work below. It will be necessary to support the slab of rock before work can proceed in this area. Support can be timbers or iron sized for the expected loads.

In all other areas of Iron Canyon where boulder stability is judged to be a problem, physical support of the boulders or rock bolts must be employed to minimize the potential for shifting. Rock bolting would be the most desirable method because the bolts could be designed to produce the desired compression to withstand boulder movement and withstand shearing from the gravitational shifting of rock.

A serious concern to performing major repair work in Iron Canyon are the geologic conditions that could change over time and effectively "ruin" the facilities at any given time due to a rock fall. Also, given the geologic make-up of the area, it could be quite expensive to excavate and remove rock where a ladder might be located, only to find that suitable foundation material for the ladder does not exist.

Dewatering

Areas requiring the placement of new concrete will need to be mostly dry. Some areas will not be too difficult to remove water, but others could be extremely challenging. The most difficult area to dewater will probably be in Iron Canyon between Weir Group 7 and Weir 9.

To remove water, temporary piping along with sandbagging and/or the use of water filled bladders and pumping may be possible for a few areas in the lower section, and may also be adequate for the entire area above Weir 9. If pool 7 and 8 need to be dry, then it may be possible to collect the majority of the creek flow near the head pool, and use flexible pipe or a flume to transport it downstream of the project site. It may be possible that if a structure is built to backwater the fish ladder exit, and if this structure were built first, it could be designed to accept that flexible pipe or flume for use in dewatering.

Staging for Construction and Scaffolding for Workers

Access to Iron Canyon and Bear Hole site locations is present along vehicle trails that are minimally maintained. In some areas, the road does not

Bill McLaughlin
March 28, 2001
Page 8

permit two-way traffic to pass. Widening of the trails leading to the project work areas may be required in order to provide access for large equipment such as cranes. If widening the trails require cuts and fills, grading recommendations should be developed.

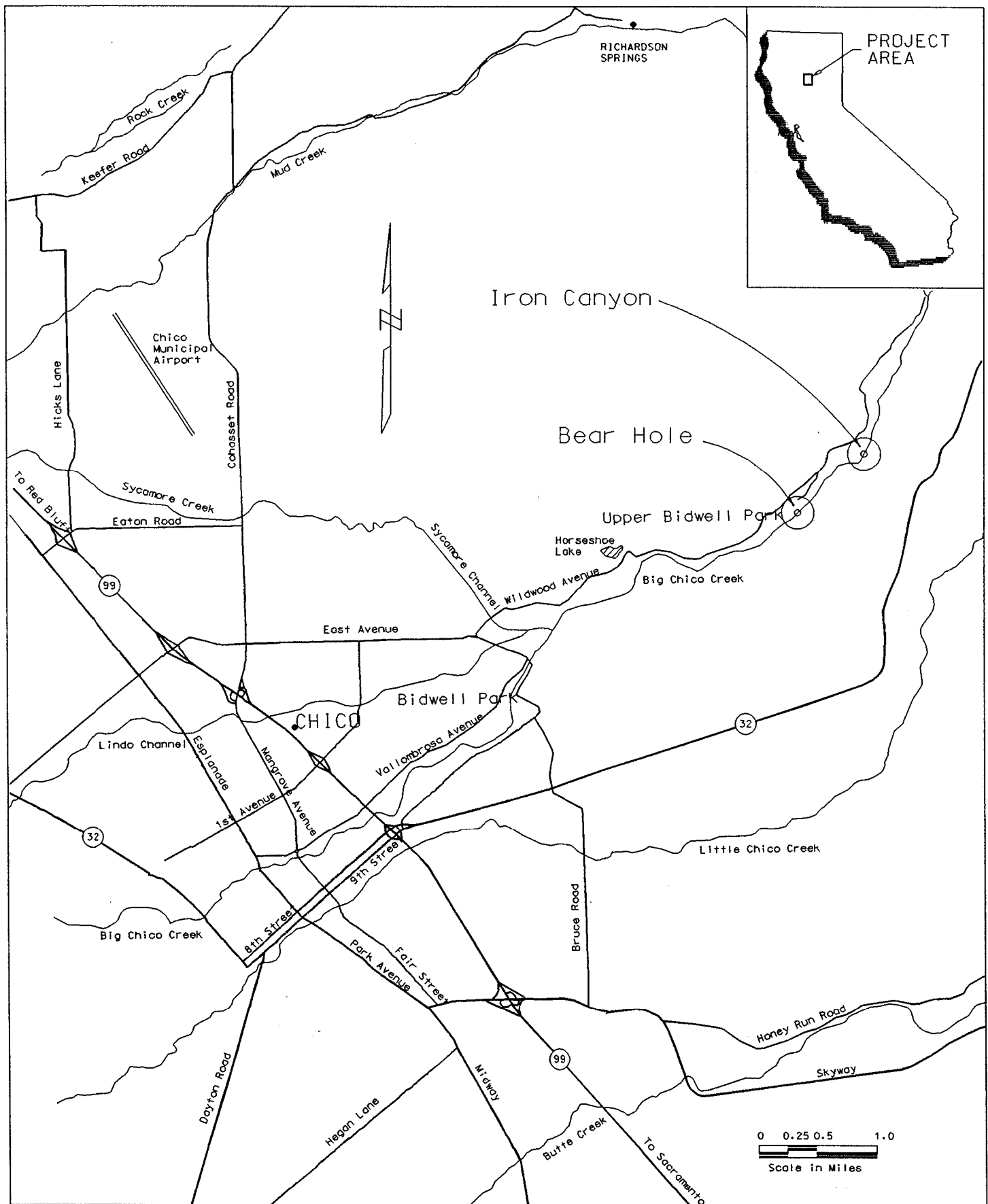
Staging the work areas near the canyon rim is geologically feasible, but large level work areas may require some grading. Grading plans for the staging areas have not yet been developed. If large level pads are developed for construction staging, then surface drainage should be designed (run-on and run-off controls) to convey surface water away to areas that will not interfere with the work at the top of the canyon or work areas in the canyon below.

The canyon rim poses a potential falling hazard to people and equipment working near the canyon rim. A Health and Safety Plan to address worker safety issues such as heat stress, personnel monitoring, first aid, work zones, and emergency services, may be warranted, depending on the future construction activities that are planned in the canyon. A geology report should be written specifically to provide information to potential bidders.

Please call me at (916) 323-8931 or Frank Glick at (916) 323-8928 if you have any questions or need additional information.

Attachment

cc: Frank Glick
Ron Lee



Location Map for
 IRON CANYON and BEAR HOLE
 FISH PASSAGE PROJECTS
 on Big Chico Creek in Chico, CA

State of California
 The Resources Agency
 Department of Water Resources

Appendix D Table of Contents

Cultural Resources Study Memorandum.....	D-2
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State of California

The Resources Agency

Memorandum

Date: September 15, 2000

To: Bill McLaughlin
Engineering Studies Section, Northern District

From: Sara Atchley, Associate State Archeologist
Environmental Services Office, Department of Water Resources

Subject: Iron Canyon and Bear Hole Fish Passage Project on Big Chico Creek

Introduction

This memorandum documents a cultural resource study conducted for the proposed Iron Canyon and Bear Hole Fish Passage Project on Big Chico Creek in Butte County, California. The study included a records search of the California Historical Resources Information System and a field survey. It was determined that no cultural resources or historic properties will be affected or impacted by the current proposed project. The methods and findings, and conclusions and recommendations of the study are discussed below

Methods and Findings

Record Search

A records search was conducted at the Northeast Information Center (NEIC) of the California Historical Resources Information System by NEIC staff on September 7, 2000. The record search included a review of the official records and maps for archaeological sites and surveys in Butte County. Also reviewed were the National Register of Historic Places, the California Register of Historical Resources, the California Inventory of Historic Resources, the California Historical Landmarks, the California Points of Historical Interest, the Historic Property Directory for Butte County, the Caltrans Local Bridge Survey, Gold Districts of California, and Historic Spots in California.

The records search revealed that while no previous cultural resource surveys have been conducted within the project area, one recorded historic-period site within the project area, the Big Chico Creek Flume. The Big Chico Creek Flume is an historic wooden flume approximately 40 miles in length that transported lumber from various

mills along Big Chico Creek from the Butte Meadows area to Chico. The flume was constructed in 1872 and operated until 1904.

Field Survey

Field survey of the proposed Iron Canyon and Bear Hole project areas was conducted on September 14, 2000 by Sara Atchley, a DWR Associate State Archaeologist. The project areas both consist of the Big Chico Creek channel and adjacent staging areas and access roads located on the north side of the creek. The Big Chico Creek channel consists primarily of large basalt boulders, gravel/sand sediments, and running water. The staging areas consist of a gravelly, shallow topsoil atop basalt bedrock. The channel, staging areas, and access roads were intensively surveyed in approximately 10 to 25 meter transects. There was no evidence of the Big Chico Creek Flume, and no cultural materials were observed in the project area.

Conclusions and Recommendations

No cultural resources or historic properties were identified within the project area, thus the proposed project would have no impact or affect on cultural resources or historic properties. If the proposed project is approved, it is recommended that the Native American Heritage Commission, interested Native American groups or individuals, and the State Historic Preservation Officer be contacted for comment and review.

The Northeast Center of the California
Historical Resources Information System

BUTTE SIERRA
GLENN SISKIYOU
LASSEN SUTTER
MODOC TEHAMA
PLUMAS TRINITY
SHASTA

Department of Anthropology
California State University, Chico
Chico, CA 95929-0400

(530) 898-6256



September 7, 2000

Sara Atchley
California Department of Water Resources
Environmental Services Office
3251 "S" Street
Sacramento, CA 95816

RE: Big Chico Creek Project; I. C. File # **H00-15**
 T22N, R2E, Sections 3, 9, 10, and 37;
 USGS Richardson Springs and Paradise West 7.5'
 and Richardson Springs and Paradise 15' quads
 Approximately 5 acres estimated from project map (Butte County)

Dear Ms. Atchley,

In response to your request, an expedited record search for the above mentioned project was conducted by examining the official maps and records for archaeological sites and surveys in Butte County. The record search was conducted within the project boundaries and within a 1/8th-mile radius of the project area.

RESULTS:

PREHISTORIC RESOURCES: According to our records, there are no recorded sites of this type known to be located in or within a 1/8th-mile radius of the project boundaries. The project is located in an area known to have been heavily utilized by the Konkow groups.

HISTORIC RESOURCES: According to our records, there is one recorded site of this type known to be located within the project area (P-04-001467). The site is recorded as the Big Chico Creek Flume. The site is plotted in red on an enclosed copy of the project map, and a copy of the site record is enclosed for your information. Additionally, the USGS 15' quad maps (1952 and 1953) indicate the historic Rancho Arroyo Chico and a road are located within the project area, and a gaging station is located in the project vicinity. In the late 1840s, General John Bidwell bought Rancho Arroyo Chico, a Mexican Land Grant, from the original grantees. There may be unrecorded historic cultural resources located within the project boundaries.

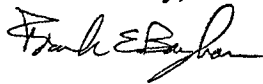
PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS: According to our records, there has been no cultural resources survey conducted in the project area or within 1/8th-mile radius of the project area.

LITERATURE SEARCH: Reviewed were the official records and maps for archaeological sites and surveys in Butte County. Also reviewed were the **National Register of Historic Places - Listed Properties and Determined Eligible Properties** (1988, Computer Listings 1966 through 7-00 by National Park Service), the **California Register of Historical Resources** (2000), **California Points of Historical Interest** (1992), **California Historical Landmarks** (1996), the **Directory of Properties in the Historic Property Data File for Butte County** (2000), the **Handbook of North American Indians, Volume 8, California** (1978), **Gold Districts of California** (1970), and **Historic Spots in California** (1966).

RECOMMENDATIONS: Based upon the above information and the local topography, the project is located in an area considered to be extremely sensitive for cultural resources. There is one recorded site, P-04-001467, known to be located within the project boundaries. Therefore, we recommend that you contact the appropriate local Native American representatives for information on unrecorded ethnographic sites, which may be located within project boundaries for which we have no records. You may also wish to consult historic GLO maps for any unrecorded historic sites, which may be located within project boundaries for which we have no records. If the projects are located within or adjacent to Forest Service or Bureau of Land Management lands, we recommend that you contact the appropriate agency for information on sites which may extend into project boundaries for which records have not yet been submitted to our office.

The charge for this record search is \$135.90 (1 hour of Expedited Information Center time @ \$135.00 per hour, plus 6 photocopies @ \$.15 per copy). An invoice from the CSUC Research Foundation for billing purposes will follow. Please feel free to contact our office if you have any questions. Thank you for your concern in preserving California's cultural heritage.

Sincerely,



Frank E. Bayham, Interim Coordinator
Northeast Information Center

OFFICE MEMO 530-898-4413

TO: ATTN: Luccia Northeast Information Center Anthropology Department, Langdon 303 California State University, Chico Chico, CA 95382	DATE: September 5, 2000
FROM: Sara Atchley Department of Water Resources FAX: 916-227-7554	SUBJECT: "Rush" Record Search Request for Big Chico Creek Project, Butte Co.

Dear NEIC Staff-

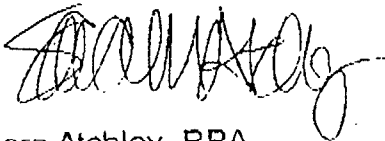
Please accept this request for a "RUSH" records search for the project area shown on the attached Richardson Springs and Paradise West USGS topo maps in Butte County. I request the search include information within a 1/8 radius of the project area.

Please send the invoice and record search results to :

Sara Atchley
California Department of Water Resources
Environmental Services Office
3251 "S" Street
Sacramento, CA 95816
FAX 916-227-7554

If you have any questions please feel free to call me at 916-227-2024.

Thank you for your assistance,



Sara Atchley, RPA

Richardson Springs 7.5'

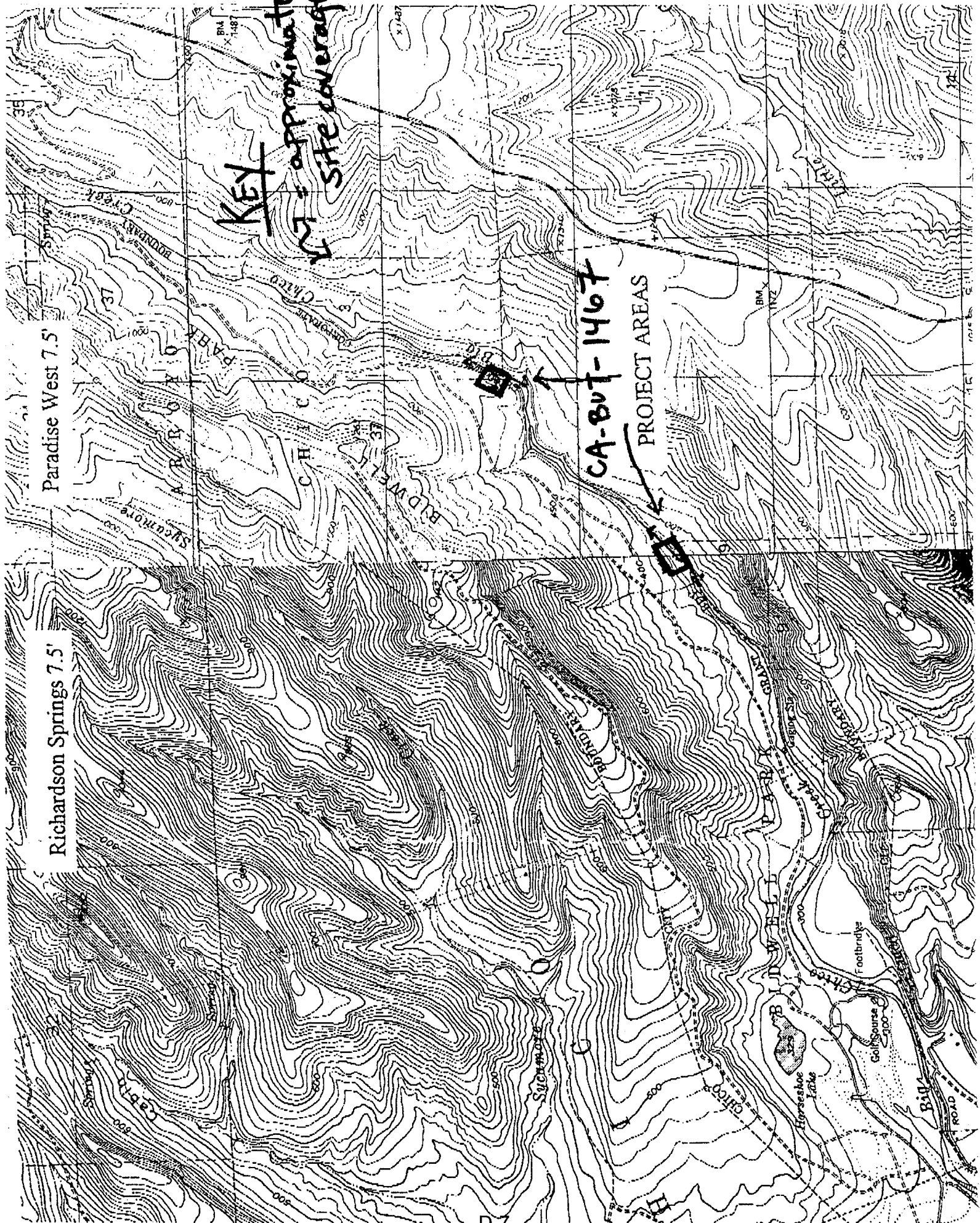
Paradise West 7.5'

~~KEY~~

CA = approximate
site coverage

CA-BUT-1467

PROJECT AREAS



State of California - The Resources Agency
Department of Parks and Recreation

PRIMARY RECORD

Page 1 of 6

Other Listings

Review Code

Reviewer

Date

Primary #

04-001467 and 52-001833

HR

Chronomial

NRHP Status Code 3S

CONFIDENTIAL

P1. Resource Name: The Big Chico Creek Flume

Other Identifier: None

UTMs: North End: 622040E, 4437670N South End: 600320E, 4398760N Devils Parade Ground, and Butte Meadows.

P2. Location: ☒ Confidential ☐ Unrestricted.

a. County: Butte and Tehama

b. USGS 7.5' Quads: Chico, Richardson Spgs, Paradise w, Cohasset, ↑ Chico Richardson Springs }
Only one segment of this flume has been documented to date through field Paradise
recording: USGS Cohasset, Calif (see attached Site Record) Butte Meadows }

T24N; R3E; SW¼ of SW¼ of Section 8; Mount Diablo B.M.

(continued page 2) Includes T22N R1E Sec's 24, 25, 26; T22N R2E Sec's 19, 18, 17, 16;

c. Address: N/A 9, 10, 13, 37; T23N R2E Sec's 1, 12, 13, 14, 23, 24, 35, 37; T24N R2E Sec 36;

d. UTM Coordinates: See attached Site Record T24N R3E Sec's 5, 8, 17, 19, 20, 30, 31;

e. Other Locational Data: See page 2. T25N R3E Sec's 29, 32, 21, 2, 3, 9, 10, 16; T26N R3E

P3a. Description: See page 2. Sec's 34, 35, 36, 25; T26N R4E Sec 30.

b. Resource Attributes: AH6

P4. Resources Present: ☐ Building ☐ Structure ☐ Object ☒ Site
☐ District ☐ Element of District ☐ Other

P5. Photograph or Drawing: None.

P6. Date Constructed/Age and Source: ☐ Prehistoric ☒ Historic ☐ Both
See page 2.

P7. Owner and Address: The flume is located on lands of various private individuals, Bureau of Land Management, Lassen National Forest, and the City of Chico.

P8. Recorded By: T. Vaughan
Coyote & Fox Enterprises, 12272 Roca Lane, Redding CA 96003

P9. Date Recorded: 8/5/98

P10. Survey Type: Very little fieldwork has been conducted on this flume, and most of the information provided here was collected through archival research.

P11. Report Citation: Cultural Resource Survey Report for the Park Vista/Bidwell Park Storm Drain Project, Chico, Butte County, California, with a History of the Big Chico Creek Flume of Butte Flume & Lumber Company, Sierra Flume & Lumber Company, and Sierra Lumber Company (1872-1904). Submitted to City of Chico, August 1998.

P12. Attachments: ☐ None ☒ Location Map ☒ Continuation Sheet ☐ Building, Structure, Object Record ☐ Archaeological Record ☐ Sketch Map ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☒ Other - additional maps

FOR PUBLIC USE ONLY
State of California - The Resources Agency
Department of Parks and Recreation

CONFIDENTIAL
CONTINUATION SHEET

Primary #

HRI #

Trinomial

Resource Name

Date: 8/5/98

04-001467 and 52-001833

The Big Chico Creek Flume

[X] Continuation [] Update

Page 2 of 6

Recorded by: T. Vaughan

P2b. USGS 7.5' Quads: (continued)

Other portions of the flume may be found in the following USGS 7.5 Quads: Butte Meadows, Devils Parade Ground, Campbell Mound, Cohasset, Richardson Springs, and Chico in the following Townships and Ranges: T22N, R1E; T22N, R2E; T23N, R2E; T24N, R3E; T25N, R3E; T26N, R3E; and T26N, R4E.

2e. Other Locational Data: The flume line historically ran from the Butte Meadows area to Big Chico Creek and followed the creek into Upper Bidwell Park. Portions of the flume in this area would be accessed from Highway 32. In Chico, the flume line ran along Chico Canyon Road/East Eighth Street to Pine Street, then turned north along Pine Street and dumped into the creek.

P3a. Description: An historic wooden flume of 40 miles in length that transported lumber from various mills along Big Chico Creek from the Butte Meadows area to Chico. There were several trestles along the flume and also way stations for the flume tenders.

P6. Date Constructed/Age and Source:

Construction of this flume began in 1872; and it operated until 1904 under the ownership of Butte Flume & Lumber Company (1872-1876), Sierra Flume & Lumber Company (1876-1878), and the Sierra Lumber Company (1878-1904). Various references documenting the history of the flume are provided in the report cited as Item P11.

NOTE: The above project which resulted in the preparation of this Primary Record covered only a small segment of ditch line, and project funding did not allow for any further field reconnaissance of the flume corridor. The attached historical map referenced below shows the flume line; and the maps following show the approximate corridor of the flume by Township/Range/Section.

Hutchinson, W. H.

1983 *California Heritage: A History of California Lumbering.* (Revised edition). The Forest History Society, Santa Cruz. On file, Special Collections, Meriam Library, California State University, Chico.

State of California - The Resources Agency
Department of Parks and Recreation

LOCATION MAP

Page 3 of 6

Map Name:

Scale: 1:24,000

Primary #

HRI #

Trinomial

Resource Name

04-001467 and 52-001833

The Big Chico Creek Flume

Date of Map:

Contour Interval:

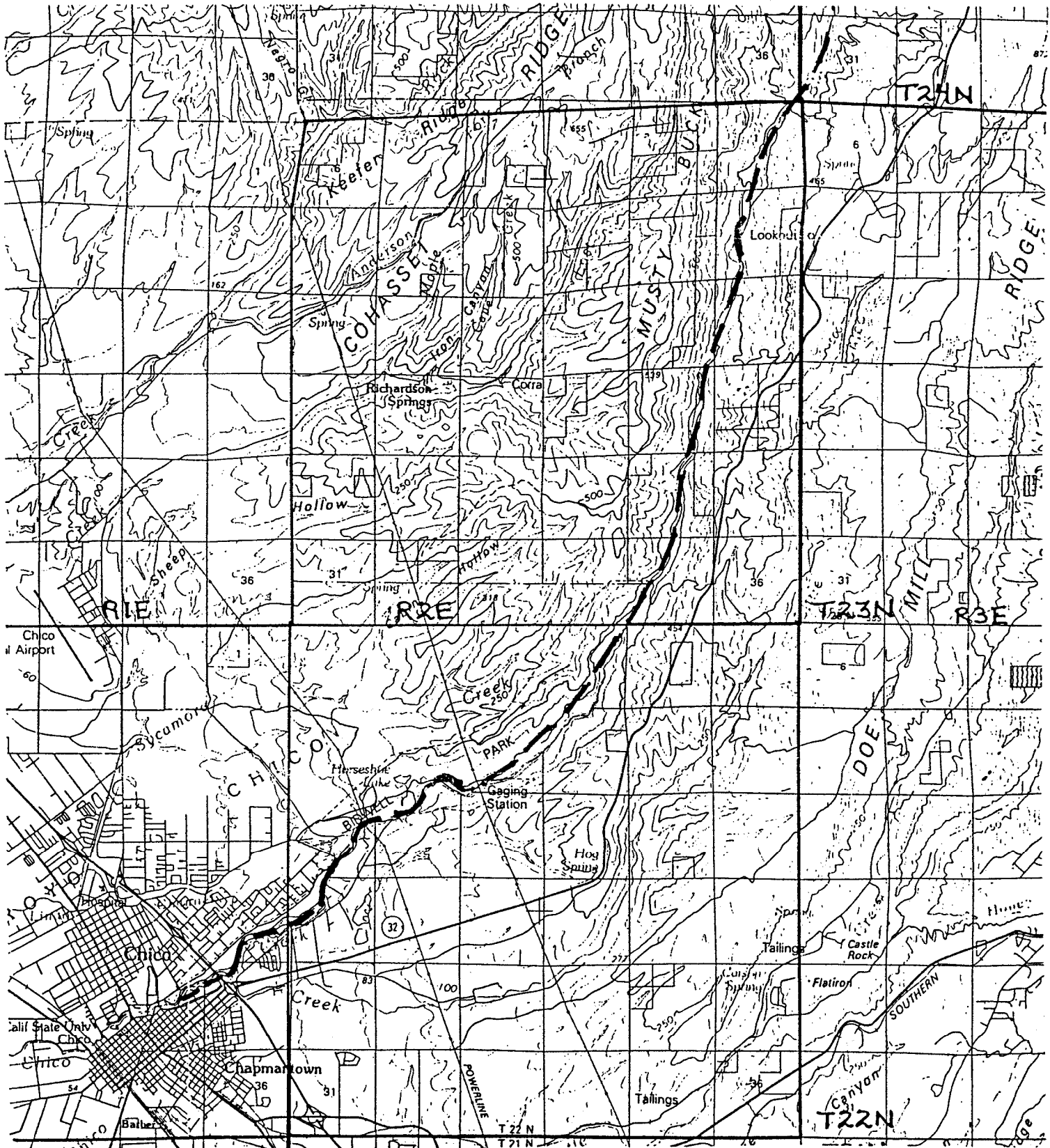
NONE (see note at bottom of page 2)

D-11

MAP 1 of 2

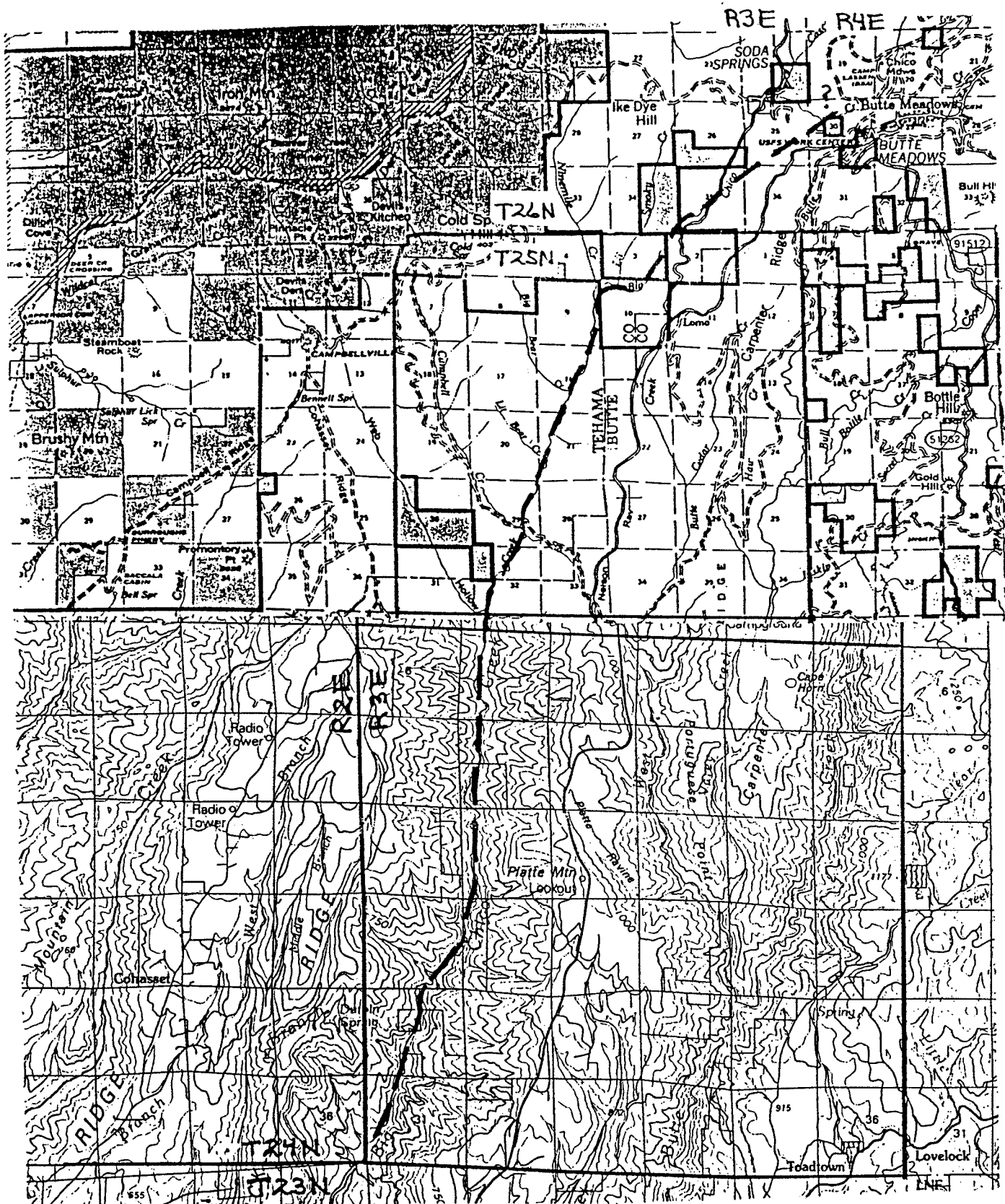
CONFIDENTIAL

Approximate path of Big Chico Creek Flume along Big Chico Creek.
 Field verification needed to determine exact alignment.
 (Map is BLM 1982 1:100,000 scale metric, Chico)



CONFIDENTIAL

[Maps are (lower) BLM 1982 1:100,000 scale metric, Chico and (upper) Lassen National Forest 1987]



Appendix E Table of Contents

Botanical and Valley Elderberry Longhorn Beetle Surveys Memorandum	E-2
Environmental Permitting and Documentation Memorandum	E-8

Memorandum

Date : July 23, 2001

To : Bill McLaughlin
Engineer, WR

Gail Kuenster
Environmental Specialist III

From : Department of Water Resources

Subject : Botanical and Valley Elderberry Longhorn Beetle Surveys for the Big Chico Creek Fish Ladder Project

Sensitive plant and valley elderberry longhorn beetle surveys were conducted during the Spring of 2000 and 2001 for the Big Chico Creek fish ladder project in Upper Bidwell Park in Chico, California. No threatened or endangered plant species were identified within the project area. One federal Species of Concern was found nearby and three plant species on the California Native Plant Society's List 4 (plants of limited distribution) were found within the survey area. No valley elderberry longhorn beetle or its habitat was located within the project area.

The proposed project is still in preliminary design phase. The intent of the project is to improve fish passage at Iron Canyon and Bear Hole on Big Chico Creek. Potential routes to access the fish ladder in Iron Canyon include an existing trail from the Salmon Hole parking lot to the fish ladder, an existing trail from the park road to the canyon rim above the fish ladder and/or an abandoned dirt road from the park road to the canyon rim (Figure 1).

Access to Bear Hole would be by the existing road and parking area for the Bear Hole swimming area and existing trails from the parking area to the creek (Figure 2).

Botanical surveys:

A search of the California Natural Diversity Database and the CNPS Inventory revealed the following sensitive plant species as having potential for occurring within the project area.

SURNAME

DWR 155 (REV. 2/86)

Kuenster 7/23/01 | E-2 Pearson 7/23/2001

Scientific Name/ Common Name	Federal Status/ State Status	CNPS List
<i>Calycadenia oppositifolia</i> Butte County calycadenia	none/ none	1B
<i>Clarkia gracilis</i> ssp. <i>albicaulis</i> white-stemmed clarkia	none/ none	1B
<i>Eleocharis quadrangulata</i> four-angled spikerush	none/ none	2
<i>Fritillaria eastwoodiae</i> Butte County fritillary	Species of Concern/ none	3
<i>Fritillaria pluriflora</i> adobe-lily	Species of Concern/ none	1B
<i>Hibiscus lasiocarpus</i> rose-mallow	none/ none	2
<i>Juncus leiospermus</i> var. <i>leiospermus</i> Red Bluff dwarf rush	none/ none	1B
<i>Limnanthes floccosa</i> ssp. <i>californica</i> Butte County meadowfoam	Endangered/ Endangered	1B
<i>Monardella douglasii</i> ssp. <i>venosa</i> veiny monardella	Species of Concern/ none	1B
<i>Paronychia ahartii</i> Ahart's paronychia	Species of Concern/ none	1B
<i>Rhynchospora californica</i> California beaked-rush	Species of Concern/ none	1B
<i>Sidalcea robusta</i> Butte County checkerbloom	Species of Concern/ none	1B

Two federal Species of Concern (California beaked-rush and rose-mallow) and two CNPS List 1B/2 (Butte County checkerbloom and Butte County calycadenia) are known to occur near the project area. Two of these species, rose-mallow and California

beaked-rush occur in seeps and wetlands; Butte County checkerbloom occurs in shallow, often rocky soils of blue oak woodland and adjacent grasslands, and Butte County calycadenia grows on thinly-vegetated shallow soil over volcanic bedrock within openings in foothill woodlands.

On March 31, 2000, Caroline Warren and I conducted an initial search of the project area. Lawrence Janeway, Environmental Specialist II, and I visited the project area on May 25, 2000 and noted the presence of CNPS List 4 species along the access trails. However, a detailed survey was not conducted at that time. On May 15 and 17, 2001, Lawrence Janeway performed surveys of each of the access routes and parking areas for the fish ladder above Salmon Hole and the area near Bear Hole. These are outlined in a draft report dated May 29, 2001, along with maps and CNDDDB field survey forms.

Although the California beaked-rush is present within the project area, use of or modification to the various trails, abandoned dirt road, and parking areas that might be used for the project will not impact this species nor will they affect its habitat. No other species listed above were found within the surveyed area.

Three species on CNPS List 4 were found within the project area. These are shield-bracted monkeyflower (*Mimulus glaucescens*), Tehama navarretia (*Navarretia heterandra*), and Bidwell's knotweed (*Polygonum bidwelliae*).

The shield-bracted monkeyflower was found along the trail to Salmon Hole. The plants were found along a narrow ephemeral drainage that crosses the trail, although there were no plants within ten feet either side of the trail. Bidwell's knotweed was found along the trail to the fish ladder. The plants were found along approximately 50 feet of trail, being thickest alongside the trail but also scattered within the trail. Tehama navarretia was found along approximately 150 feet of the upper edge of the Bear Hole parking area and along approximately 160 feet of the adjacent trail to the southwest. Most plants were found immediately adjacent to the area of greatest disturbance and also scattered within the disturbed area (i.e. in the middle of the trail).

I recommend using the abandoned dirt road for access to the bluff above the fish ladder. No species of concern were found at this location. If access along the upper trail is unavoidable, we need to discuss the possibility of lessening the impacts to the Bidwell's knotweed by flagging the population and/or relocating the trail slightly. The access trail to Salmon Hole and the fish ladder following the creek crosses wetlands at the top of the bluff. The shield-bracted monkeyflower should not be impacted. However, because of its proximity to the trail, we should flag the population prior to start of any work in the area. The impacts to the Tehama Navarretia near the Bear Hole

parking lot and trail can also be lessened by flagging the population and a site visit prior to the start of work.

The southwest side of the creek between Bear Hole and the Diversion Dam was not surveyed. An extensive seep area occurs on the flats above the creek. This is potential habitat for the beaked rush or shield-bracted monkeyflower. Any work in this area as well as any area not covered in these surveys will need to have further sensitive plant surveys.

Valley elderberry longhorn beetle surveys:

The valley elderberry longhorn beetle is listed by the U.S. Fish and Wildlife Service as "threatened, with Critical Habitat". Several populations and habitat for the beetle are known to occur near the project area.

No habitat for the valley elderberry longhorn beetle occurs along the stretch of Big Chico Creek near Salmon Hole to the fish ladder or near Bear Hole. This species would not occur along the upper footpaths or access road. Thus, no impact to the beetle is expected from this project.

Enclosures

Figure 1

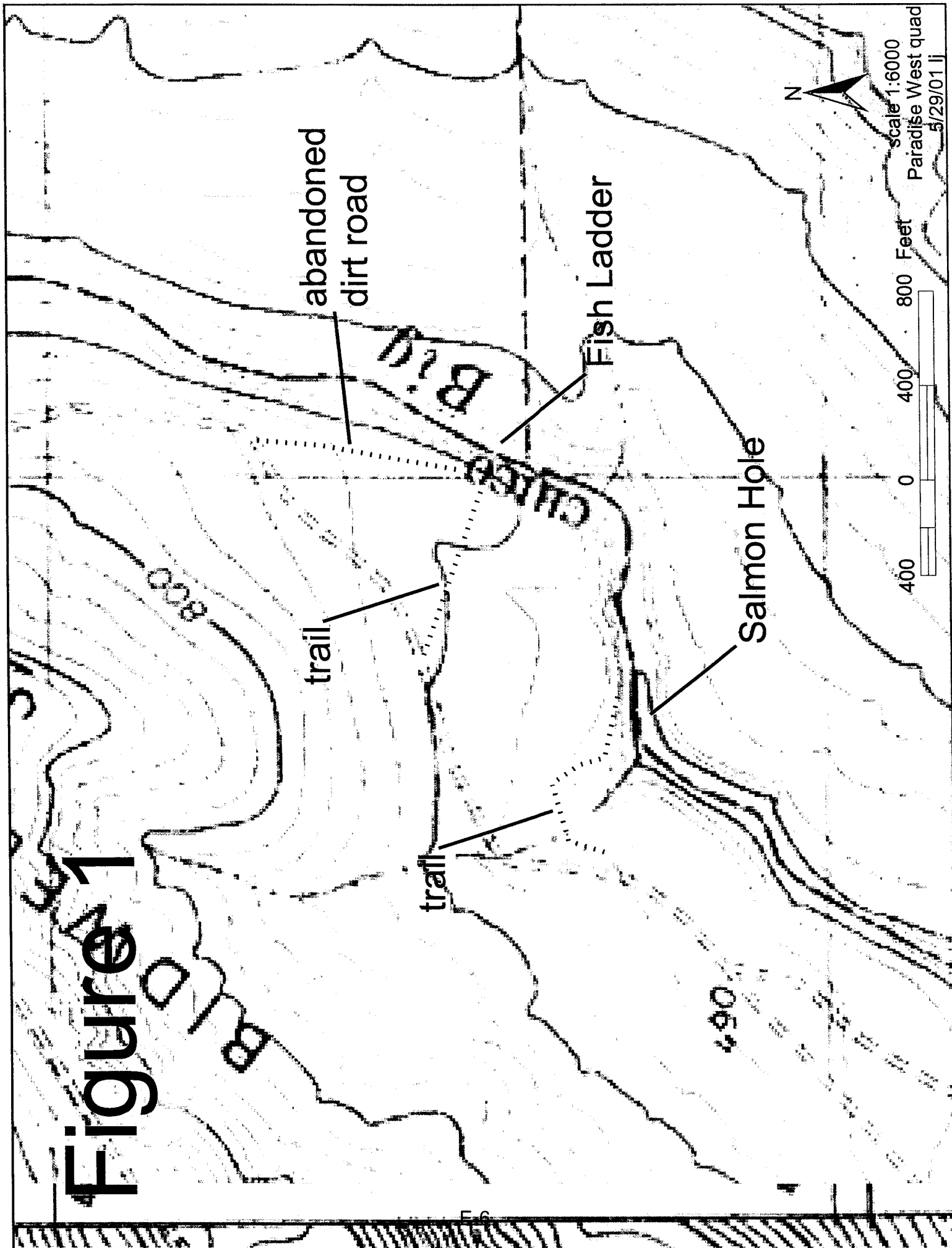
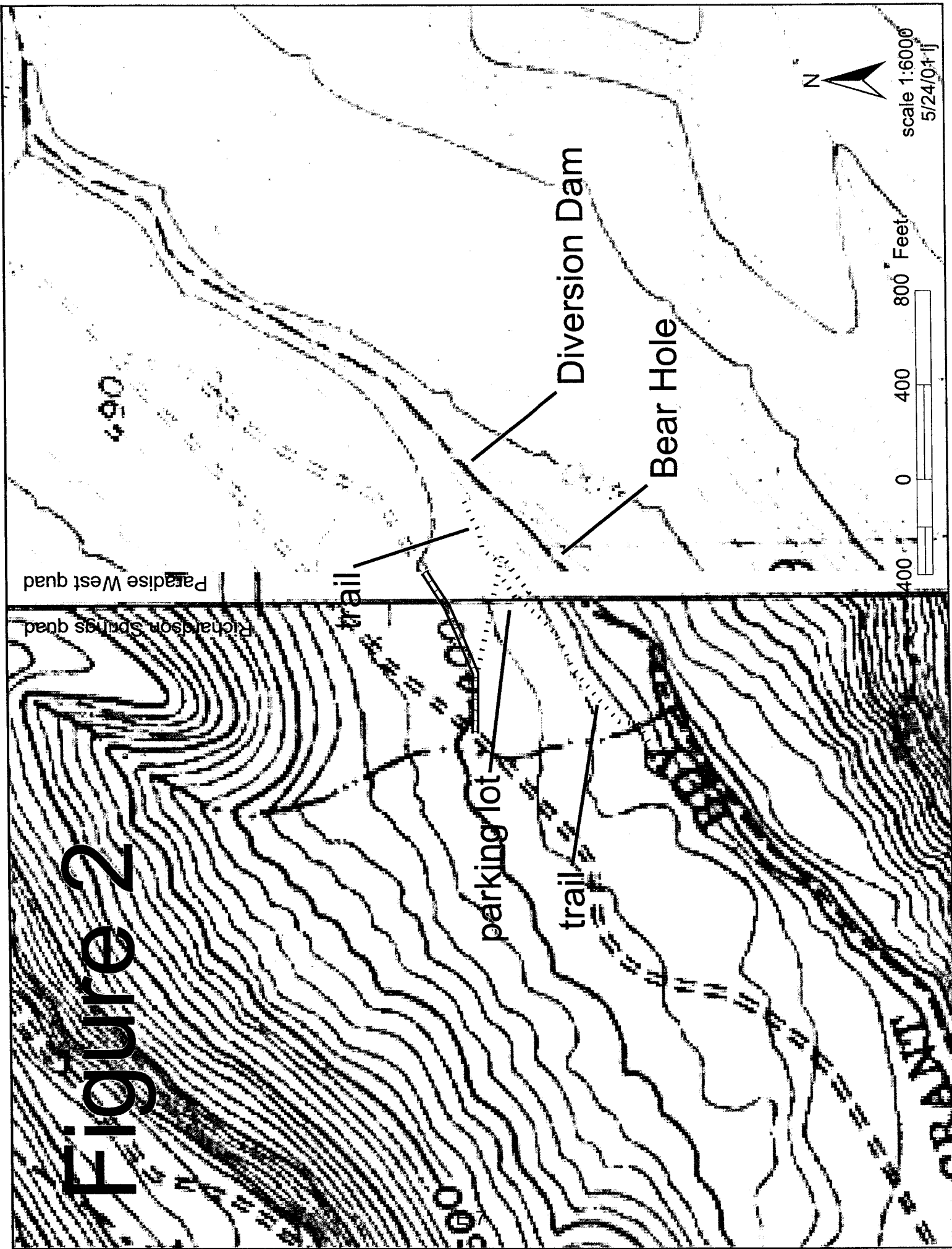


Figure 2



September 27, 2001

Bill McLaughlin

Dave Bogener

Big Chico Creek Fish Passage Restoration Projects

Project Description

The Iron Canyon and Bear Hole Fish Passage Projects on Big Chico Creek, Preliminary Engineering Investigation developed preliminary designs and construction cost estimates to improve fish passage at Iron Canyon and Bear Hole. The intent of the project is to improve the survival and conditions of fish attempting to get to their historic holding and spawning areas above Iron Canyon.

For Iron Canyon, the technical working group has proposed repairing the existing fish ladder structure within its limits to provide 1½ foot jumps throughout the entire fish ladder. The work would include repairing or replacing worn out concrete, excavation of materials within pools to increase volume throughout the fish ladder, and installing up to 5 new weir structures within the limits of the existing fish ladder. The entire fish ladder will need to be dewatering in sections to do the repair work.

For Bear Hole, the technical working group has proposed constructing 2 gradient control structures downstream of the constriction in the creek. The project site will need to be dewatered so the concrete structures can be keyed into the bottom of the channel. The structures would span the entire width of the creek and raise the water surface to make fish passage easier past the constriction.

Environmental Reconnaissance

During the initial phases of project alternative development, a series of environmental reconnaissance were conducted within the project areas. The intent of these field surveys was to identify potential environmental problems early in the planning process. These data were utilized by the project engineers and technical working group to design project alternatives, which minimized or avoided most potential environmental issues.

These initial field reconnaissance included evaluation of potential project impacts on State and federally listed plants and animals, cultural and historical resources, jurisdictional wetlands, water quality, and CEQA checklist items. A list of potential project permitting requirements was also provided. I have revised the permitting list based on the selected preferred alternative for each project, and new biological information.

Environmental Permitting and Documentation

Compliance with several environmental laws or permit requirements will be necessary prior to initiation of the proposed project alternatives. These laws/permits include the California Environmental Quality Act, California Department of Fish and Game Streambed Alteration Agreement, State and federal Endangered Species Acts, U.S. Army Corp of Engineers 404 Permit, and California Regional Water Quality Control Board Water Quality Certification. The Bear Hole and Iron Canyon projects are evaluated separately as permit requirements differ between the two proposed projects.

CEQA

Evaluation of the projects indicates that the proposed actions are not statutorily exempt under CEQA. Categorical Exemption 15302 applies to replacement or reconstruction of existing structures and facilities where the new structure will be located at the same site as the original one and will have substantially the same purpose and capacity as the original. The proposed actions at Iron Canyon appear to qualify under this Categorical Exemption. Under CEQA regulations use of this categorical exemption is not applicable if 1). the activity may have a significant environmental impact because of unusual circumstances, 2). Significant cumulative impacts, 3). project affects scenic resources within State designated scenic highway, 4). Project is located on a toxic waste site designated by California EPA, and 5). Project causes substantial adverse changes in significant historical resources. Examination of the potential project effects under these screening criteria indicates that the use of Categorical Exemption 15302 appears appropriate for CEQA compliance. A CEQA Notice of Exemption may be filed with the State Clearinghouse and Butte County. Preparation and filing of a NOE is not required under CEQA. However, a NOE serves as documentation of agency decision making and also limit the appeal period to 35 days.

The Bear Hole fish passage improvements are not categorically exempt and will require preparation of a CEQA document (neg dec, mitigated neg dec, or EIR). Attached is an updated CEQA checklist for project scoping and planning purposes.

Streambed Alteration Agreement

Because the proposed projects involve modification of the bed, bank, channel, or associated vegetation, a California Department of Fish and Game Streambed Alteration Agreement will be required. Documentation of CEQA compliance is a requirement component of the Streambed Alteration Agreement. Streambed Alteration Agreements normally take about 30 days to process.

State and federal Endangered Species Acts

Numerous State or federally “listed” species may occur in the project area or in downstream areas potentially affected by the project (Table 1). Analyses indicates that implementation of the proposed projects will have a positive effect on both State and federal listed species including steelhead, Central Valley winter-run chinook salmon, and Central Valley spring-run chinook salmon. Winter-run chinook salmon occur in the watershed but do not reach the project area (Paul Ward, DFG personnel communication). The project purpose is to improve passage and habitat quality for these species. However, the federal Endangered Species Act requires consultation with the National Marine Fisheries Service on any project with the potential to impact these species including either positive or negative impacts. An ESA section 7 consultation (rather than a section 10a consultation) is appropriate for this project as a federal Clean Water Act 404 Permit (federal nexus) will be required.

A separate Section 7 consultation with U.S. Fish and Wildlife Service may also be required related to potential impacts to California red-legged frog. A recent red-legged frog sighting by a DFG biologist at the Bidwell Park golf course has been reported. The project area does not provide habitat for this federally listed “Threatened” species and project related impacts should be very localized and short-term. No take of red-legged frog or their habitat should occur. However, US Fish and Wildlife Service will have to make an official determination during the consultation process. Habitat for Valley elderberry longhorn beetle exists within the general project area, as does potential habitat for several federally listed vernal pool invertebrates. The project is designed to avoid impacts to these species and their habitats. However, it would be prudent to include evaluation of project effects on these species as part of the U.S. Fish and Wildlife Service consultation. A minimum of 130 days is required for a formal consultation under the federal endangered species act.

Clean Water Act 404 Permit

Both Nationwide and Individual Permits may be authorized by the USACOE. Nationwide Permits generally have a more streamlined process and are designed for projects where impacts are limited. The proposed project involves construction, reconstruction, and repair of structures located within the Waters of the U.S. These structures are considered fill under the Clean Water Act 404 definition and require a 404 Permit from the U.S. Army Corp of Engineers.

The Iron Canyon passage improvements may qualify under Nationwide Permit #3 Maintenance. This permit allows activities related to repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure, or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3 provided the structure or fill is not put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification. Minor deviations in the structure’s configuration or filled areas, including changes in materials, construction techniques, or current

construction codes or safety standards which are necessary to make repair, rehabilitation, or replacement are permitted, provided the adverse environmental effects resulting from such repair, rehabilitation, or replacement are minimal.

If the Bear Hole improvements (new construction) are pursued as a separate project they would meet the requirements under Nationwide Permit 18 Minor Discharges. Under this Nationwide Permit the quantity of discharged material and the volume of excavated area does not exceed 25 cubic yards or result in the loss of greater than 1/10 acre of wetland.

Both the Iron Canyon and Bear Hole projects will require temporary dewatering during construction. Nationwide Permit 33 Temporary Construction, Access, and Dewatering allows temporary structures, work, and discharges, including cofferdams, necessary for construction activities to be placed in Waters of the U.S. This Nationwide Permit contains a lengthy list of conditions and constraints, which may limit dewatering options. Nationwide Permits generally take less than 30 days for USACOE review.

Water Quality Certification

Some USACOE Nationwide Permits also require water quality certification by the State of California. The Regional Water Quality Control Boards can and frequently do require additional conditions or best management practices to minimize water quality degradation. All three Nationwide Permits applicable to these projects also require water quality certification by the Regional Water Quality Control Board.

If you have any questions concerning the information provided in this summary, please contact me at (530) 529-7329.

Table 1. List of State and Federally "Listed" Plant and Animals Potentially Occurring within the Proposed Iron Canyon and Bear Hole Fish Passage Improvement Project Areas.

Species	Status	Species	Status
American peregrine falcon	SE	valley elderberry longhorn beetle	FT
bald eagle	SE, FT	Conservancy fairy shrimp	FE
Bewick's wren	FSC	longhorn fairy shrimp	FE
black swift	MNBMC	vernal pool fairy shrimp	FT
California horned lark	CSSC, MNBMC	vernal pool tadpole shrimp	FE
Cooper's hawk	CSSC	California linderiella	FSC
ferruginous hawk	CSSC, MNBMC	Yuma myotis bat	FSC, CSSC
golden eagle	CSSC	long-eared myotis bat	FSC, CSSC
lark sparrow	MNBMC	fringed myotis bat	FSC, CSSC
Lawrence's goldfinch	MNBMC	long-legged myotis bat	FSC, CSSC
Lewis' woodpecker	FSC	small-footed myotis bat	FSC, CSSC
loggerhead shrike	CSSC, MNBMC	Townsend's western big-eared bat	FSC, CSSC
long-billed curlew	CSSC, MNBMC	Pacific western big-eared bat	FSC
long-eared owl	CSSC	pallid bat	CSSC
merlin	CSSC	little brown myotis bat	FSC, CSSC
northern harrier	CSSC	greater western mastiff bat	FSC
osprey	CSSC	spotted bat	FSC
prairie falcon	CSSC	Marysville kangaroo rat	FSC, CSSC
purple marten	CSSC	San Joaquin pocket mouse	FSC, CSSC
red-breasted sapsucker	FSC	American badger	CSSC
rufous hummingbird	MNBMC	river lamprey	FSC, CSSC
sharp-shinned hawk	CSSC	winter-run chinook salmon	SE, FE
Vaux's swift	CSSC, MNBMC	steelhead Central Valley ESU	FT
western burrowing owl	CSSC, MNBMC	Pacific lamprey	FSC, CSSC
white-tailed kite	MNBMC	Central Valley spring-run chinook salmon	FT, ST
yellow warbler	CSSC	Butte County calycadenia	CNPS 1B
California red-legged frog	FT, CSSC	white-stemmed clarkia	CNPS 1B
foothill yellow-legged frog	FSC, CSSC	four-angled spikerush	CNPS 2
northwestern pond turtle	FSC, CSSC	Butte County fritillary	CSSC
California horned lizard	FSC, CSSC	adobe lily	CSSC
KEY FE=federal endangered FT=federal threatened SE=State endangered ST=State threatened FSC=federal species of concern CSSC=California species of special concern California Native Plant Society List MNBMC=federal migratory nongame bird of management concern		rose-mallow	CNPS 2
		Red Bluff dwarf rush	CNPS 1B
		Butte County meadowfoam	SE
		veiny monardella	CSSC
		Ahart's paronychia	CSSC
		Californica beaked-rush	CSSC
		Butte County checkerbloom	CSSC
Status per DFG Natural Diversity Database July 2000			

Environmental Checklist Form

1. Project title: Iron Canyon and Bear Hole Fish Passage Improvement Projects

EVALUATION OF ENVIRONMENTAL IMPACTS:

1) A brief explanation is required for all answers except “No Impact” answers that are adequately supported by the information sources a lead agency cites in the parentheses following each question. A “No Impact” answer is adequately supported if the referenced information sources show that the impact simply does not apply to projects like the one involved (e.g., the project falls outside a fault rupture zone). A “No Impact” answer should be explained where it is based on project-specific factors as well as general standards (e.g., the project will not expose sensitive receptors to pollutants, based on a project-specific screening analysis).

2) All answers must take account of the whole action involved, including off-site as well as on-site, cumulative as well as project-level, indirect as well as direct, and construction as well as operational impacts.

3) “Potentially Significant Impact” is appropriate if there is substantial evidence that an effect may be significant. If there are one or more “Potentially Significant Impact” entries when the determination is made, an EIR is required.

4) “Negative Declaration: Potentially Significant Unless Mitigation Incorporated” applies where the incorporation of mitigation measures has reduced an effect from “Potentially Significant Impact” to a “Less Significant Impact.” The lead agency must describe the mitigation measures, and briefly explain how they reduce the effect to a less than significant level (mitigation measures from Section XVII, “Earlier Analyses,” may be cross-referenced).

5) Earlier analyses may be used where, pursuant to the tiering, program EIR, or other CEQA process, an effect has been adequately analyzed in an earlier EIR or negative declaration. Section 15063(c)(3)(D). Earlier analyses are discussed in Section XVII at the end of the checklist.

6) Lead agencies are encouraged to incorporate into the checklist references to information sources for potential impacts (e.g., general plans, zoning ordinances). Reference to a previously prepared or outside document should, where appropriate, include a reference to the page or pages where the statement is substantiated.

7) Supporting Information Sources: A source list should be attached, and other sources used or individuals contacted should be cited in the discussion.

8) This is only a suggested form, and lead agencies are free to use different ones.

9) The analysis of each issue should identify:

- a) the significance criteria or threshold used to evaluate each question;
- and b) the mitigation measure identified, if any, to reduce the impact to less than significance

SAMPLE QUESTION

I –AESTHETICS

Would the project:

a) Have a substantial adverse effect on a scenic vista?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact

b) Damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

c) Substantially degrade the existing visual character or quality of the site and its surroundings?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact

d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

2 –AGRICULTURE RESOURCES:

In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model prepared by the California Dept. of

Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:

- a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland) to nonagricultural use? (The Farmland Mapping and Monitoring Program in the California Resources Agency, Department of Conservation, maintains detailed maps of these and other categories of farmland.)
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- c) Involve other changes in the existing environment which, due to their location or nature, could individually or cumulatively result in loss of Farmland, to nonagricultural use?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

3 –AIR QUALITY

Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:

- a) Conflict with or obstruct implementation of the applicable Air Quality Attainment Plan or Congestion Management Plan?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- b) Violate any stationary source air quality standard or contribute to an existing or projected air quality violation?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

c) Result in a net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

d) Create or contribute to a non-stationary source "hot spot" (primarily carbon monoxide)?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

e) Expose sensitive receptors to substantial pollutant concentrations?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

f) Create objectionable odors affecting a substantial number of people?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

4 –BIOLOGICAL RESOURCES

Would the project:

a) Adversely impact, either directly or through habitat modifications, any endangered, rare, or threatened species, as listed in Title 14 of the California Code of Regulations (sections 670.2 or 670.5) or in Title 50, Code of Federal Regulations (sections 17.11 or 17.12)?

- ☒ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☐ No Impact

- b) Have a substantial adverse impact, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact
- c) Have a substantial adverse impact on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact
- d) Adversely impact federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) either individually or in combination with the known or probable impacts of other activities through direct removal, filling, hydrological interruption, or other means?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact
- e) Interfere substantially with the movement of any resident or migratory fish or wildlife species or with established resident or migratory wildlife corridors, or impede the use of wildlife nursery sites?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- f) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- g) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Conservation Community Plan, or other approved local, regional, or state habitat conservation plan?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

5 –CULTURAL RESOURCES

Would the project:

- a) Cause a substantial adverse change in the significance of a historical resource which is either listed or eligible for listing on the National Register of Historic Places, the California Register of Historic Resources, or a local register of historic resources?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- b) Cause a substantial adverse change in the significance of a unique archaeological resources (i.e., an artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it contains information needed to answer important scientific research questions, has a special and particular quality such as being the oldest or best available example of its type, or is directly associated with a scientifically recognized important prehistoric or historic event or person)?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- c) Disturb or destroy a unique paleontological resource or site?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- d) Disturb any human remains, including those interred outside of formal cemeteries?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

6 –GEOLOGY AND SOILS

Would the project:

a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

ii) strong seismic ground shaking?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

iii) Seismic-related ground failure, including liquefaction?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

iv) Inundation by seiche, tsunami, or mudflow?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

v) Landslides?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

vi) Flooding, including flooding as a result of the failure of a levee or dam?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

- vii) Wildland fires, including where wildlands are adjacent to urbanized areas and where residences are intermixed with wildlands?
- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact
- b) Would the project result in substantial soil erosion or the loss of topsoil?
- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact
- c) Would the project result in the loss of a unique geologic feature?
- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact
- d) Is the project located on strata or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?
- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact
- e) Is the project located on expansive soil creating substantial risks to life or property?
- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact
- f) Where sewers are not available for the disposal of waste water, is the soil capable of supporting the use of septic tanks or alternative waste water disposal systems?
- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

7 –HAZARDS AND HAZARDOUS MATERIALS

Would the project:

- a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the likely release of hazardous materials into the environment?
- ☐ Potentially Significant Impact
☒ Less than Significant With Mitigation
☐ Less than Significant
☐ No Impact
- c) Reasonably be anticipated to emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- d) Is the project located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?
- ☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

h) Expose people or structures to the risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

8 -HYDROLOGY AND WATER QUALITY

Would the project:

a) Violate Regional Water Quality Control Board water quality standards or waste discharge requirements?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (i.e., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact

c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

d) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems to control?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

e) Place housing within a 100-year floodplain, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

f) Place within a 100-year floodplain structures which would impede or redirect flood flows?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact

9 -LAND USE AND PLANNING

Would the project:

a) Physically divide an established community?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

- b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- c) Conflict with any applicable habitat conservation plan or natural communities conservation plan?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

10 -MINERAL RESOURCES

Would the project:

- a) Result in the loss of availability of a known mineral resource classified MRZ-2 by the State Geologist that would be of value to the region and the residents of the state?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

11 -NOISE

Would the project result in:

- a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact
- b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact
- e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

12 -POPULATION AND HOUSING

Would the project:

- a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

13 -PUBLIC SERVICES

- a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:

Fire protection?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

Police protection?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

Schools?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

Parks?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact

Other public facilities?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☒ Less than Significant
- ☐ No Impact

14 –RECREATION

- a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

- b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?

- ☐ Potentially Significant Impact
- ☐ Less than Significant With Mitigation
- ☐ Less than Significant
- ☒ No Impact

15 –TRANSPORTATION/TRAFFIC

Would the project:

- a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- d) Substantially increase hazards to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- e) Result in inadequate emergency access?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact
- f) Result in inadequate parking capacity?
☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact

- g) Conflict with adopted policies supporting alternative transportation (e.g., bus turnouts, bicycle racks)?
- ☐ Potentially Significant Impact
 - ☐ Less than Significant With Mitigation
 - ☐ Less than Significant
 - ☒ No Impact

16 –UTILITIES AND SERVICE SYSTEMS

Would the project:

- a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?
- ☐ Potentially Significant Impact
 - ☐ Less than Significant With Mitigation
 - ☐ Less than Significant
 - ☒ No Impact
- b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?
- ☐ Potentially Significant Impact
 - ☐ Less than Significant With Mitigation
 - ☐ Less than Significant
 - ☒ No Impact
- b) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?
- ☐ Potentially Significant Impact
 - ☐ Less than Significant With Mitigation
 - ☐ Less than Significant
 - ☒ No Impact
- c) Are sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?
- ☐ Potentially Significant Impact
 - ☐ Less than Significant With Mitigation
 - ☐ Less than Significant
 - ☒ No Impact

- d) Has the wastewater treatment provider which serves or may serve the project determined that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- e) Is the project served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

17 - MANDATORY FINDINGS OF SIGNIFICANCE

- a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?

☒ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☐ No Impact

- c) Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☐ Less than Significant
☒ No Impact

- d) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?

☐ Potentially Significant Impact
☐ Less than Significant With Mitigation
☒ Less than Significant
☐ No Impact

e) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?

☐ Potentially Significant Impact

☐ Less than Significant With Mitigation

☐ Less than Significant

☒ No Impact